Ontario

Status of the Fish Community and Fisheries in Eastern Lake Erie

Results from the 2000-2004 East Basin Rehabilitation Plan

Lake Erie Management Unit
March, 2006

The Lake Erie Management Unit of the Ontario Ministry of Natural Resources is responsible for managing the fishery resources of the Ontario waters of Lake Erie, as well as the upper Niagara River, the Detroit River, Lake St. Clair, and the St. Clair River.

Ontario has been responsible for managing the fishery resources of these waters since 1898. In 1992, the Lake Erie Management Unit was created to improve Ontario's ability to manage those important resources. The Unit is based in London with field offices in Port Dover and Wheatley.

VISION: The Lake Erie Management Unit will contribute to the environmental, social, and economic well-being of the people of Ontario through the sustainable development of fishery resources within the Lake Erie basin.

MISSION: To ensure the long-term health of the Lake Erie ecosystem and to promote the sustainable harvest and development of its fishery resource through sound science, assessment, regulation, and advocacy.

GOAL: To foster and encourage the understanding of all users and partners on the complexity of managing the fishery resource of Lake Erie, to minimize conflict, and to endorse sound fishery management practices.

Lake Erie's fishery resources are managed cooperatively by Ontario and the four U.S. states – New York, Pennsylvania, Ohio and Michigan - bordering the lake through a process set out by the Great Lakes Fishery Commission and the Joint Strategic Plan for Management of Great Lakes Fisheries. Lake St. Clair's fishery resources are managed cooperatively by Ontario and Michigan under the same process.

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Forward

The mission of the Ontario Ministry of Natural Resources (OMNR) is to ensure sustainable development of our natural resources. As such, it requires knowledge of the distribution of the resource and sustainability at an appropriate spatial scale. The Great Lakes Water Quality Agreement (1972) has benefitted the quality of Lake Erie by reducing phosphorus loads into the lake which has led to improved water quality. The ecology of Lake Erie was disturbed by the proliferation of zebra and quagga mussels since 1987, and there is considerable evidence that the eastern basin was the most strongly impacted region of the lake.

In response, fisheries managers in Ontario and around the lake took action to reduce fish harvests in keeping with the declining productivity of fish stocks. For example, in 1999, Ontario's commercial and recreational fishing stakeholders agreed with OMNR to participate in a five year rehabilitation strategy for eastern Lake Erie to allow fish stocks to recover and provide an indication of their potential productivity after the arrival of zebra and quagga mussels. Conservation measures focussed on reducing and re-distributing fishery harvest, spatially and temporally. An enhanced fisheries program included strengthening the OMNR-Ontario Commercial Fisheries Association (OCFA) partnership survey in the Haldimand-Niagara area, a summer recreational fishing survey in 2003, a winter recreational fishing survey in 2004 in Long Point Bay, research into the identification of walleye stocks and habitat suitability, and investigation of issues affecting the rehabilitation of the Grand River walleye stock.

Our commercial and recreational fishery groups, including the OCFA, the Ontario Federation of Anglers and Hunters (OFAH), the Long Point Bay Anglers Association, and the Port Colbourne and Dunnville Angling clubs, have worked effectively with OMNR, particularly through a technical committee which advised OMNR during the five year period.

Strong partnerships were also developed during this period with Environment Canada, Ministry of Environment, Grand River and Long Point Region Conservation Authorities. In addition, our partnerships were renewed with the Aylmer and Guelph Districts of the Ontario Ministry of Natural Resources. The Canada-Ontario Agreement (COA) came into effect during this time period and this agreement helped us address rehabilitation issues in eastern Lake Erie. We need to continue to work with our many partners to achieve the goals of COA.

This report is an overview of the status of the eastern basin fisheries and the results of consultations with the stakeholders, reflecting a concerted and dedicated effort by all.

I hope that this report will help you to become an informed participant in the discussion about the management of eastern Lake Erie's fisheries. I appreciate all of the input, work, advice and your continued support as we move forward with the management of the eastern basin of Lake Erie.

Michael J. Morencie
Manager
Lake Erie Management Unit

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1.0 Introduction

1.1 The Five Year Plan for Rehabilitation of Eastern Lake Erie Fisheries

The Ontario Ministry of Natural Resources (OMNR) conducted a comprehensive assessment of the fish community and fisheries of eastern Lake Erie that documented the loss of biodiversity, dominance of exotic fish species, depressed population status of valued native species and the instability of the fish community (Ryan *et al.* 1999). Strategies for management were made more difficult, because the eastern basin, with its distinctive habitat and aquatic community, makes up only part of MNR's much larger Quota Area 3. Paine and Halyk (1999) noted that Quota Area 3, made up of the waters of Lake Erie off Elgin, Norfolk, and Haldimand counties plus Niagara region, was the largest management area in the Great Lakes. These authors made a strong case for independent management of the eastern basin to ensure that management could occur following the principles outlined in the Strategic Plan for Ontario Fisheries (SPOF II; OMNR 1992; Section 5.0 of this report).

From 2000 to 2004 inclusive, the eastern basin of Lake Erie has been managed according to a rehabilitation initiative entitled the East Basin Rehabilitation Plan, with the active collaboration and support of commercial and recreational fishers. Fish populations were monitored during this period and additional work was undertaken to try to understand the management issues specific to this area of the lake. The successful completion of the plan will occur in four steps. First, this report was prepared to provide background information about the fisheries and habitats, and determine the current status of valued fish populations. Second, this information was used to support dialogue with users about how to manage this resource. In the third step, management alternatives were developed by the East Basin Technical Committee in January 2005 and presented for public consultation in February 2005. The last step will be the development of a management strategy for the eastern basin. This strategy will be used to manage eastern basin fisheries starting in 2006.

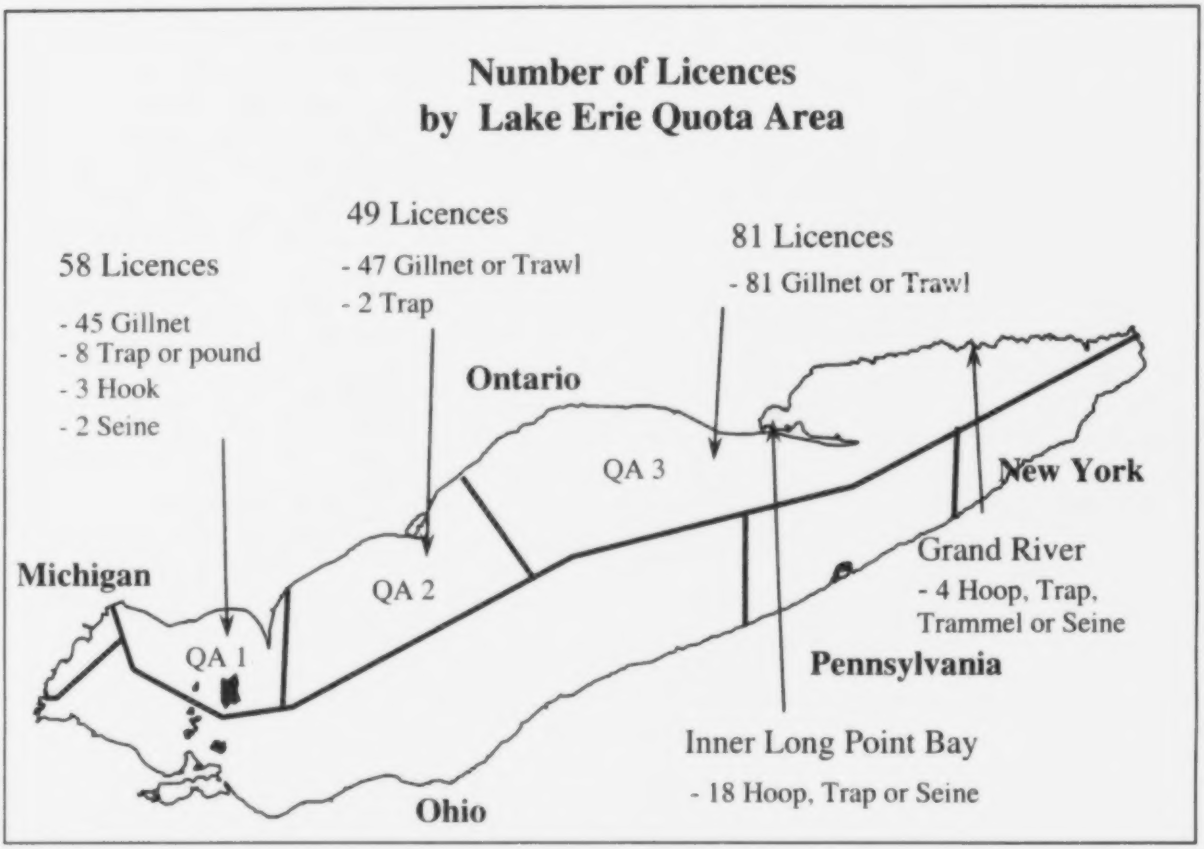
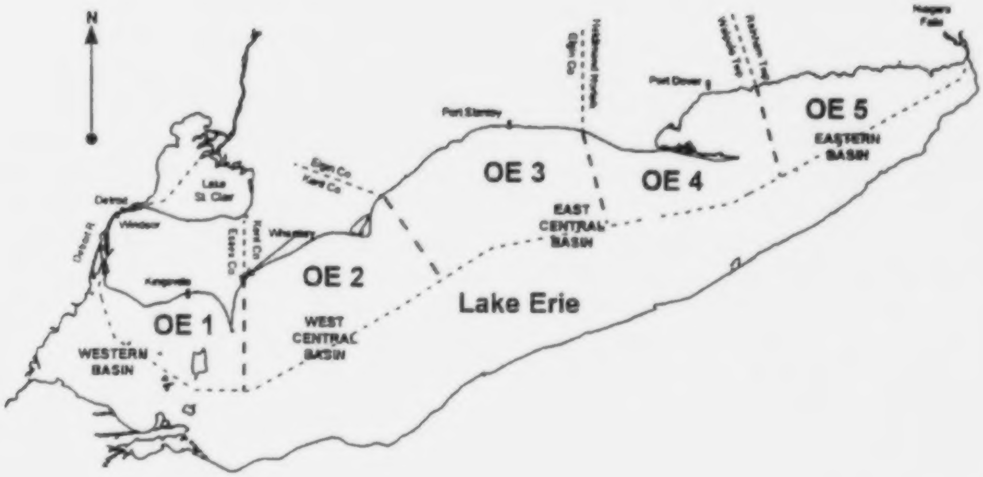

Number of Licences
by Lake Erie Quota Area
58 Licences
- 45 Gillnet
- 8 Trap or pound
- 3 Hook
- 2 Seine
49 Licences
- 47 Gillnet or Trawl
- 2 Trap
81 Licences
- 81 Gillnet or Trawl
Ontario
QA 3
New York
QA 2
Michigan
Grand River
- 4 Hoop, Trap, Trammel or Seine
QA 1
Pennsylvania
Inner Long Point Bay
- 18 Hoop, Trap or Seine
Ohio

Figure 1.1-1. Map of Lake Erie showing quota areas for commercial fishery management and commercial fisheries licenced lake-wide.


N
Lake St. Clair
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Kent Co
Wheatley
Elgin Co
Kent Co
Port Stanley
Elgin Co
Port Dover
Niagara Falls
OE 1
WESTERN BASIN
OE 2
WEST CENTRAL BASIN
Lake Erie
OE 3
EAST CENTRAL BASIN
OE 4
OE 5
EASTERN BASIN

Figure 1.1-2. Map of Lake Erie identifying the 5 statistical districts in Ontario waters (OE1, OE2, OE3, OE4, OE5).

1.2 Ecology of Eastern Lake Erie

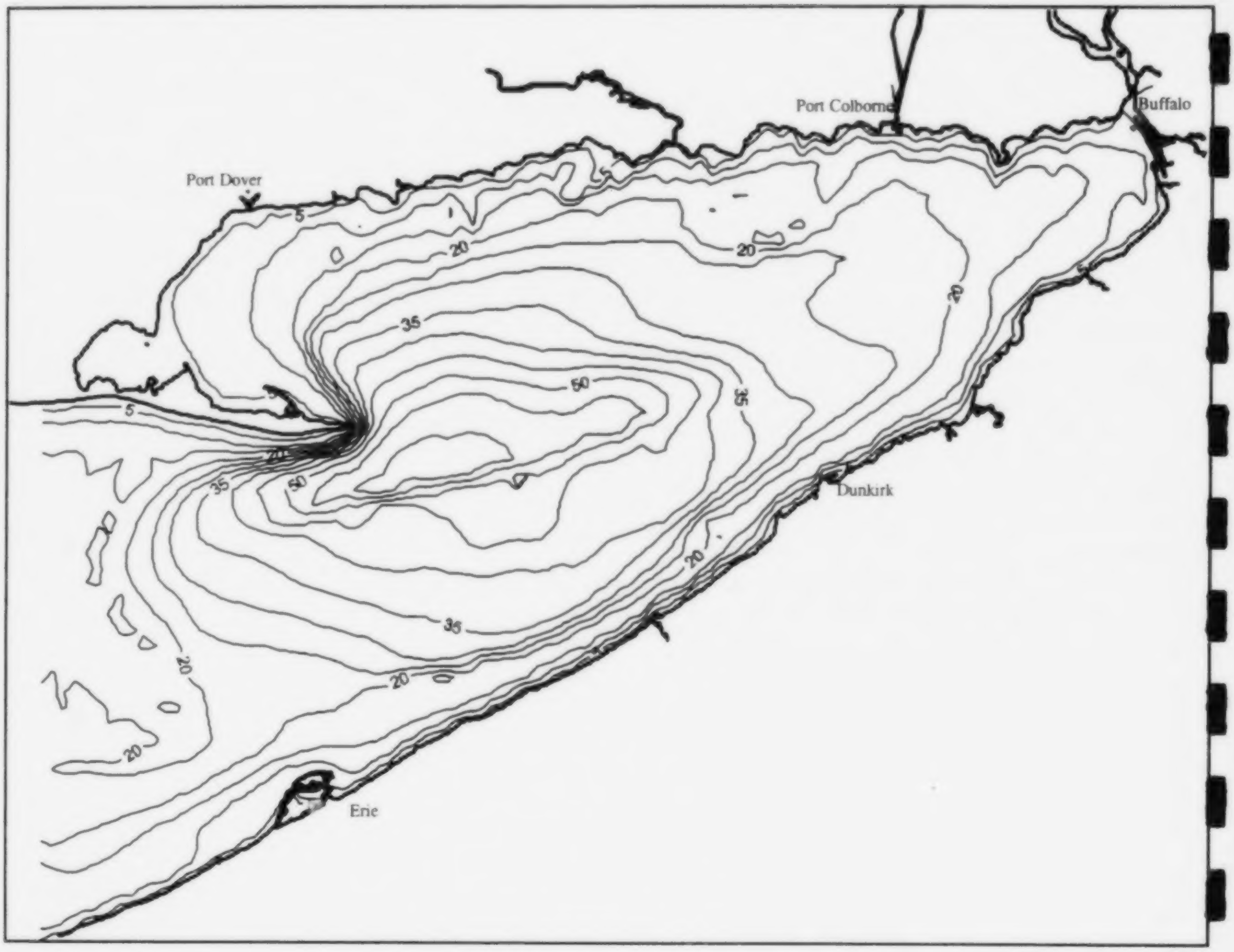
The eastern basin of Lake Erie favours a different fish community from the other basins due to its physical and environmental characteristics. The eastern basin is by far the deepest of the three basins of Lake Erie, with an average depth of 24.4 m and a maximum depth of 64.0 m (Hartman 1972, Figure 1.2-1). The eastern basin represents 24.3% of the lake's area and 31.9% of the lake's volume. Mud bottoms predominate in the deeper waters. Much of the south shore is precipitous and consists of exposed bedrock and deposits of sand and gravel. In contrast, the north shore is flat, dominated by the Haldimand clay plain and Norfolk sand plain (Burns 1985). High bluffs occur to the west end of the basin, but the nearshore area is predominantly exposed bedrock and deposits of sand and gravel. The Port Huron moraine (also known as the Pennsylvania Ridge) crosses the lake from Long Point, ON to Erie, PA (Burns 1985), as a submerged ridge which separates the eastern basin from the central basin. The eastern basin receives most of its water from the upstream central basin, but also has major river inflows on the north shore from the Grand River, and on the south shore from Cattaraugus Creek (Sly 1976). Extensive areas of marsh and wetlands are found in Long Point Bay and in the lower reaches of the Grand River.

Winter temperature conditions in the eastern basin distinguish it from the other Great Lakes as well. Water temperatures can approach zero (<0.1°C, Stewart 1973) if the lake remains open and circulating. When ice breaks up in the spring in the western and central basins, ice floes typically move east and pack over the eastern basin, delaying spring warming of surface waters (Hartman 1972). Thereafter warming is rapid and a thick metalimnion is formed, which narrows and sinks as the summer progresses. The epilimnion reaches nearly 24°C by early August then starts to cool by early September. The hypolimnetic water warms slowly and reaches 7-9°C before fall turnover which usually occurs in late October. The eastern basin can be classified as deep dimictic, meaning the basin stratifies thermally and exhibits a thick hypolimnetic layer of cold water. This feature separates it dramatically from the rest of the lake.

The native fish community was described by harvests from early commercial fisheries which included lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), blue pike (*Stizostedion vitreum glaucum*), lake sturgeon (*Acipenser fulvescens*) and lake herring (*Coregonus artedii*) . The lake trout, sturgeon and whitefish harvests were not sustained and declined to comparatively low levels before 1892 (Dominion Fishery Commission 1894). Lake herring and blue pike became the focus of the fishery until the collapse of the herring fishery in the 1920s. The blue pike fishery continued until the late 1950s (Regier *et al.* 1969, Hartman 1972, Leach and Nepszy 1976, Schneider and Leach 1979).

By the 1960s, the fish community of eastern Lake Erie had undergone radical changes in composition as indicated by the focus of the major commercial fisheries in eastern Lake Erie on the exotic rainbow smelt (*Osmerus mordax*) and yellow perch (*Perca flavescens*). The blue pike was rare (later considered extinct, Campbell, 1987b), lake herring were considered extirpated, and a deep-water cisco (*Coregonus alpenae*) that had not been discovered until the 1960s (Scott and Smith, 1962), has not been observed since. Lake whitefish, lake sturgeon and walleye (*Sander vitreus*) were still present at low population numbers.

The fish populations of eastern Lake Erie have been affected by commercial fishing (1850 to present), recreational fishing, eutrophication (pre 1972) and its reversal "oligotrophication" (post 1972), changes in abundance of top predator species (sea lamprey (*Petromyzon marinus*), salmonines, walleye) and colonization by exotic species (rainbow smelt, alewife (*Alosa pseudoharengus*), white perch (*Morone americana*), zebra and quagga mussels (*Dreissena* spp)., round goby (*Neogobius melanostomus*), spiny water flea (*Bythotrophes cederstroemi*) and fishhook water flea (*Cercopagis pengoi*)).


Port Colborne
Buffalo
Port Dover
5
20
20
20
35
50
35
5
20
35
50
Dunkirk
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35
20
20
20
Erie

Figure 1.2-1. Bottom contours in eastern Lake Erie at intervals of 10 m.

1.3 Management of Eastern Basin Fisheries

The commercial fishery in the Ontario waters of eastern Lake Erie includes trawling for rainbow smelt, and gillnet fishing for walleye, yellow perch and lake whitefish. The commercial fishers operate out of Port Colborne, Port Maitland, Nanticoke and Port Dover. A fishery using hoop and seine nets occurs in the nearshore waters of Inner Long Point Bay. It harvests carp (*Cyprinus carpio*), bowfin (*Amia calva*), sunfish (*Lepomis* spp.), crappies (*Pomoxis* spp.), yellow perch and northern pike (*Esox lucius*). Most of these fish are marketed live. A hoop net fishery in the Grand River focuses on coarse fish. There are significant recreational fisheries in both U.S. and Canadian waters; offshore for walleye, rainbow trout (*Oncorhynchus mykiss*), lake trout and pacific salmon species (*Oncorhynchus* spp.), and nearshore for yellow perch, smallmouth bass (*Micropterus dolomieui*), walleye, crappies and sunfish. A winter fishery for yellow perch, northern pike and sunfishes exists in Long Point Bay.

Ontario coordinates their fisheries management with four US jurisdictions (New York State, Pennsylvania, Ohio and Michigan) through the Lake Erie Committee of the Great Lakes Fishery Commission (GLFC) and follows the Strategic Plan for Great Lakes Fisheries Management (GLFC 1987, 1998). Federal agencies are signatories to the plan, and lead or support in specific areas. Canada's Department of Fisheries and Oceans co-leads with U.S. Fish and Wildlife Service the Lamprey control program and is responsible for enforcing the habitat provisions of the Fisheries Act across the Canadian side of the Great Lakes. The Ontario Ministry of Natural Resources[1] manages fisheries under authority of the federal Fisheries Act, as delegated to the province. The Lake Erie Committee (LEC) establishes annual lakewide harvest levels for walleye and yellow perch, and develops specific conservation strategies and management plans by consensus. The eastern basin is primarily managed with New York State and Pensylvania agencies, but involves discussion with all LEC member agencies for an integrated lake mangement approach. Ontario participated in a lakewide conservation initiative for walleye and yellow perch from 2001-2003 (Coordinated Percid Management Strategy) (Great Lakes Fisheries Commission 2000), and initiated its own initiative concerning the eastern basin in 2000, which is the subject of this report.

Quota Management

Commercial fisheries in Lake Erie have been managed using an individual transferable quota system (ITQ) since 1984 (Cowan and Paine 1997). Under this system, known as the modernization of the commercial fishery, commercial licence-holders have shares in the quota for a given quota area (Figure 1.3-1).

Prior to the ITQ system, the management policy was to control fishing effort by limiting the amount of gear that could be used. These effort controls were easily circumvented, and the fishery was essentially open access. Under these conditions, all licence-holders were in competition for fish. This created an economic spiral of investment in gear and boats and reduced the profit in the fishery.

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[1] OMNR delivers its fisheries management role through the Lake Erie Management Unit (LEMU) for the lake, and through Aylmer and Guelph District offices for tributaries. LEMU has a front counter service role for commercial fisheries. All other counter service i.e. recreational and bait fisheries, land use permits etc is delivered by Guelph and Aylmer District and area offices (Vineland, Chatham).

A substantial number of licences were bought out just before the ITQ system was put in place, to reduce the "over-capitalization" in the industry. At the same time, mesh size restrictions were put in place, replacing fish size restrictions, and a "Daily Catch Report" (DCR) system was initiated (Appendix 1). The Daily Catch Reporting system has become a valuable source of information on the operation of the fisheries and provides assessment data through analysis of commercial harvest, catch and effort. The completion of DCRs is mandatory for each trip and must be completed and signed by the captain and presented to the Port Officer (Deputy Conservation Officer) or placed in a sealed box before the catch can be landed. Fish are landed in standardized containers and declared weights are subject to inspection.

The terms and conditions on commercial licences include specification of the total amount of harvest that can be taken by species and gear type. The licence is valid within one specified quota area for one year. If quotas are reasonable in relation to fish supply, they reduce the competition to get the fish before they are gone, and allow the licence holder to plan their fishery to optimize economic return by catching fish for seasonal high prices while avoiding over-capitalization.

Lake Erie's commercial fishing industry unsuccessfully challenged the ability of the province to set quotas in 1984. They also requested an external review of the OMNR management program which was completed in 1987 (English *et al.* 1986). All of the recommendations from this review were addressed. A particularly valuable result was the "Partnership Index Fishing Program," a joint assessment program conducted by the Ontario Commercial Fisheries Association and OMNR that was initiated in 1989 and continues to present.

Commercial fishing was administered from three district offices of OMNR until 1992 – Niagara licences (12) for fisheries based in Ports Maitland and Colborne, Simcoe licences (37) for fisheries based in Nanticoke, and Port Dover, and 17 for Inner Bay of Long Point, and Aylmer licences (37) for fisheries based in Port Burwell, and Port Stanley.

Smelt Harvest Management

Beginning in 1984, a quota was established for smelt in Quota Area 3 (QA3) which includes the eastern basin of Lake Erie (Figure 1.3-1). In 1994, a maximum harvest level or cap was established for statistical districts OE 4 and OE 5 (figure 1.1-2) within QA3. The restriction, the first independent regulation of smelt harvest in the eastern basin, was put in place in response to dramatic declines in eastern basin smelt abundance, growth and survival, as a consequence of zebra and quagga mussel impacts (Ryan *et al.* 1999). Under the cap system, licence-holders can harvest a share of the allowed harvest or cap in the eastern basin, and are allowed to harvest the balance of their quota in the east central basin (OE 3). Individual licence-holders can choose to harvest their entire quota in the central basin part of the quota area.

A Smelt Advisory Committee (SAC), composed of OMNR, commercial fishing industry and OFAH representatives, was established in September 1993 under the direction of the Minister of Natural Resources to conduct a survey of smelt abundance and other work to address information needs for management. Questions posed by commercial fishers concerning the use of smelt forage by stocked salmonids led to an analysis of the predator demands for forage in the central and eastern basins (Einhouse *et al.* 1993). The establishment of a smelt cap was accompanied by reduced stocking of salmonids by New York and Pennsylvania. The smelt cap was set at 6 million lbs for 1994, was reduced to 5 million lbs for 1995-1999, and increased to 5.5 million lbs in 2000 and to 6.9 million lbs in 2003. Smelt harvest regulations were not modified during the East Basin Rehabilitation Plan period (2000-2004).

From 1992 to1994, trawl gear experiments were conducted in order to evaluate the potential to (a) reduce by-catch in smelt trawls, (b) selectively target white perch and (c) selectively target lake whitefish (Scantec Ltd. 1994). Favourable results were obtained in the smelt trawl trials using Nordmore Grates to exclude fish larger than smelt, but the technology has not been adapted to full size smelt trawls. A decline in white perch abundance led to discontinuance of the selective fishing trials for that species. Lake whitefish trials of modified commercial trawl gear were conducted over a number of years. The experimental whitefish trawl fishery harvested whitefish and burbot. Issues with the handling and storage of burbot limited the use of this fish species for commercial fishing, but these issues are currently being investigated by researchers at the University of Guelph, in partnership with the United States Geological Survey (USGS) and OMNR.

Licence conditions state that fishermen can only use one gear type on the same day (i.e. trawls or gill nets). Trawls can only be used to target smelt. If other quota species are caught while trawling for smelt, (e.g. yellow perch, walleye, and whitefish), they must be landed and a maximum of 10% of the weight of smelt can be counted against the quota for those bycatch species held by the licencee (i.e. the combined weight of all the by-catch species must be within 10% of the weight of the smelt to be counted against quota). Additional fish must be surrendered to the Crown. This allowance was increased to 20% in 2003. In 2003, a total cap of 15,000 pounds of yellow perch bycatch was made for the trawl fishery in OE 4 and OE5[2] (essentially the East Basin Rehabilitation Zone). Once this bycatch cap was met, trawling for smelt in the zone would be stopped. Non-quota species that may be caught in trawls include fish like freshwater drum (sheepshead *Aplodinotus grunniens*), white perch (*Morone Americana*) and white bass (*Morone chrysops*), and suckers, but there are no restrictions on the bycatch of these non-quota species.

Walleye Harvest Restrictions (Walleye Cap)

When modernization of the commercial fishery was implemented in 1984, the 12 Niagara District commercial licencees agreed to restrict their harvest of walleye in the Haldimand-Niagara part of the eastern to 7,000 pounds per licence. Walleye quota above this level had to be harvested west of the Long Point Peninsula. The reason for this restriction is suspected to be in response to concerns from the recreational fishing community that commercial walleye harvest would reduce availability of walleye to the recreational fishery in the Port Colborne area. During the 1984 to 1992 period, the annual harvest of walleye in OE 5 by Niagara area licences ranged from approximately 14,000 to 67,000 lbs.

The fishery was operated under this condition until the re-organization of the OMNR and the creation of the Lake Erie Management Unit in 1992. The agreement was not in effect in 1992 and 1993 because it was inadvertently overlooked during the transition in management responsibilities from the District to Lake Unit. In 1993, OE 5 walleye harvest rose dramatically from 32,000 lbs in 1992 to approximately 230,000 lbs. This prompted an examination which resulted in the re-discovery of the walleye harvest cap and the initiation of negotiations with Niagara area recreational and commercial fishers to re-establish a walleye cap. Following consultation, the LEMU imposed a restriction of

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[2] Lake Erie is divided into five statistical districts in Ontario waters (OE 1-5), set up by the Great Lakes Fishery Commission, initially for statistical analysis of commercial fishing (Hile, R. Collectiona and analysis of commercial fishing statistics in the Great Lakes. Great Lakes Fish. Comm Tech. Rep. No 5. 34p) . A map showing the divisions can be found in Figure 1.1-2.

10,000 lbs. per licence for the waters of OE 5 only, coupled with a landing restriction which prevented the landing of walleye in Niagara ports by QA3 licencees not based in the Niagara area.

The revised cap on walleye harvest was less restrictive to Niagara area commercial fishers than the cap that was in place prior to 1992. The cap was raised by 3,000 lbs per licence (from 7, 000 to 10,000 lbs) and Niagara area licencees did not have to go west of Long Point to harvest the remainder of their walleye quota.

Long Point Bay Hoop and Seine Fishery Management

A relatively small commercial hoop and seine net fishery operates in Long Point Bay within the zone where gill and trawl nets are prohibited. This is one of the oldest continuously operated commercial fisheries on the Great Lakes (circa 1870-1880). Licencees have territories within which they set hoop nets or drag seines. Fish are held in pens until shipped live to market. Game fish species (e.g. smallmouth bass, largemouth bass) cannot be harvested and must be released. The harvest includes black crappie, sunfish, rock bass, freshwater drum, carp, bowfin, northern pike and yellow perch. Northern pike and yellow perch harvest are controlled via quotas assigned to each licence.

The fishery is seasonally restricted by condition of licence to January 1 to the second Saturday in May (spring fishery) and September 1 to December 31 (fall fishery). This restriction has been in place for several decades. The restriction was likely implemented to minimize conflicts with the active spring and summer boating and recreational fishing period. The fishery is also constrained by ice cover and duck hunting activity (which takes place from late September to late December).

Long Point Bay Gill and Trawl Closed Area (One Mile Line)

Gill and trawl nets are excluded year-round from the portion of Long Point Bay west of a line which is off the north shore of the bay from Port Dover to Turkey Point, then continues southeast to the Bluff Bar (Figure 1.3-2). This boundary (known locally as the "Mile Line") has been in place for many decades and pre-dates the modernization of the Lake Erie commercial fishery in 1984. Recent trends in harvest and effort cannot be attributed to the One Mile Line since this restriction pre-dates the current management regime by many years.

Seasonal Long Point Bay Line (Bass Line)

A seasonal extension to the Mile Line in Long Point Bay was imposed by OMNR in 1989 to protect smallmouth bass from incidental gill net harvest. This restriction is in effect from July 1 to September 30 and extends 1 km beyond the 1 Mile Line between Turkey Point and Port Ryerse, then carries on in an easterly direction to Peacock Point (with an additional extension around the Nanticoke Shoal (see Figure 1.3-2). The 1 km extension of the Turkey Point to Port Dover 1 Mile Line had previously been in place in 1988 for the months of July and August. The restriction has had the greatest impact on yellow perch fishing out of Port Dover. Operators of small commercial fishing boats that are not able to freely move into the more open waters have been most affected.

Niagara Nearshore Seasonal Closure

A licence condition restricts commercial licencees from fishing nearshore location between Lowbanks (just east of the mouth of the Grand River) and Fort Erie between May 1 and September 30 inclusive. The restriction prohibits fishing north of a line lying (approximately) between Mohawk Island (off the mouth of the Grand River) and Point Abino and extending east to the New York border (Figure 1.3-3). This restriction has been in place since at least the early 1970's.

Recreational Fishery Restrictions

Provincial fish sanctuaries were established at 5 locations in eastern Lake Erie to protect spawning smallmouth bass (Table 1.3-1). Four sanctuaries from Port Colborne to Fort Erie protected bass from June 1 to July 15th annually. In 1984, an annual sanctuary in Long Point Bay was put in place to protect bass from May 15 to the last Saturday in June.

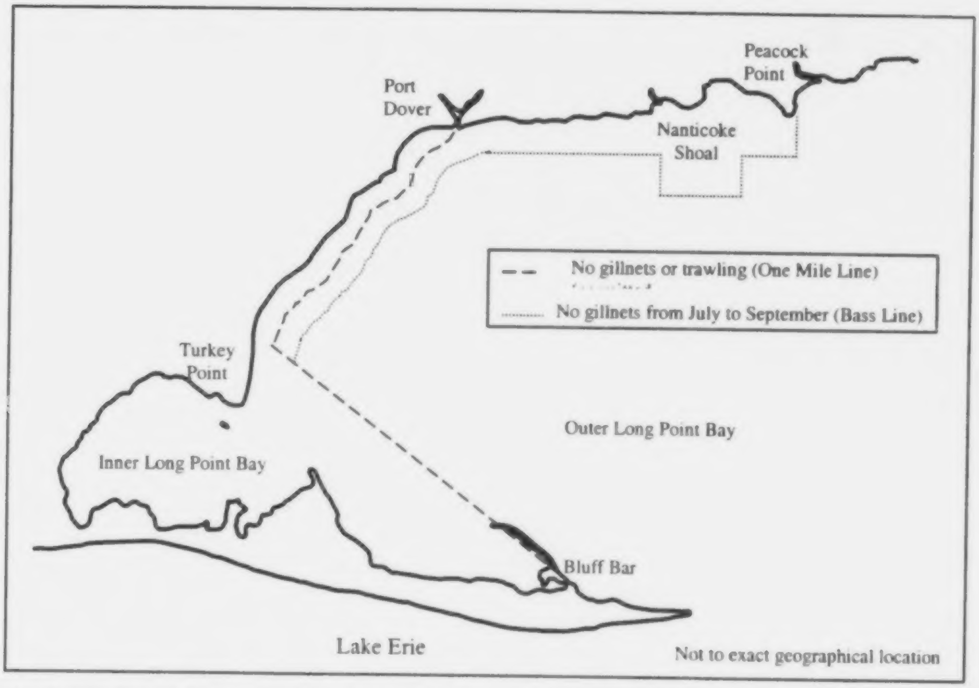
Peacock Point
Port Dover
Nanticoke Shoal
No gillnets or trawling (One Mile Line)
No gillnets from July to September (Bass Line)
Turkey Point
Outer Long Point Bay
Inner Long Point Bay
Bluff Bar
Lake Erie
Not to exact geographical location

Figure 1.3-1. Long Point Bay commercial fishing restrictions, denoting One Mile Line and Seaonal Long Point Bay Line (Bass Line).

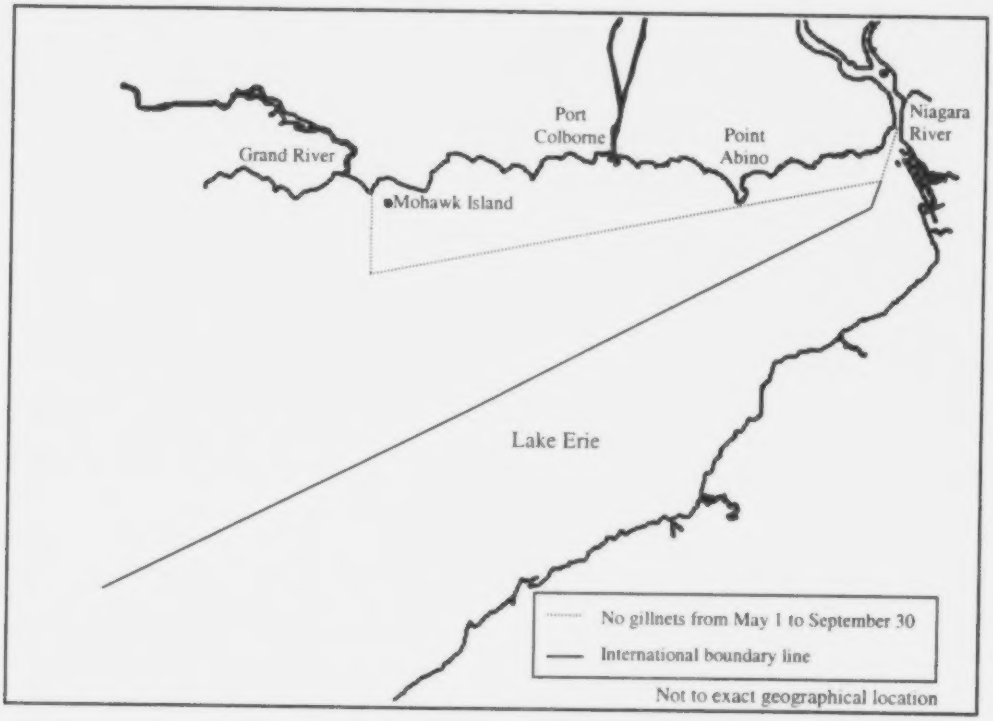
Port Colborne
Niagara River
Point Abino
Grand River
•Mohawk Island
Lake Erie
No gillnets from May 1 to September 30
International boundary line
Not to exact geographical location

Figure 1.3-2. Niagara nearshore seasonal commercial fishing closure.

Table 1.3-1. Location and conditions of fish sanctuaries established to protect spawning smallmouth bass.

Location	Period
Port Colborne east of Sugarloaf Point	June 1-July 15
Port Colborne east of Cassaday Point	June 1-July 15
Port Colborne west of Welland Canal in Gravelly Bay	June 1-July 15
Fort Erie to east of Windmill Point	June 1-July 15
Norfolk County, Inner Bay of Long Point between Long Point and Turkey Point	May 15-last Saturday in June

2.0 Fisheries Management 2000-2004

2.1 Changes in Regulations for the Rehabilitation Period

After consultation with commercial and recreational fisheries representatives, a series of changes were made to support conservation and rehabilitation in the commercial and recreational fisheries. Initially, these are as follows:

1. Rehabilitation zone established with western boundary at 80° 25'00" (east side of Grid 163, near base of Long Point), southern and eastern boundary at the international boundary (see Figure 2.1-1).

2. A walleye cap area (also known as Niagara Cap area) from the Niagara River to the east side of Grid 100 near Tecumseh Reef and south to the international boundary (figure 2.1-1).

3. Reduced commercial quotas of yellow perch to 40,000 lbs and walleye to 192,000 lbs, with only 32,000 lbs from the walleye cap area.

4. Commercial walleye fishing in rehabilitation zone closed from March 15 to second Saturday in May to protect spawning walleye.

5. Walleye recreational fish season closed from March 15 to second Saturday in May to protect spawning walleye.

6. Walleye recreational daily catch and possession limit reduced from 6 to 4 fish in the Rehabilitation Zone and the Grand River downstream of the Caledonia Dam.

7. For the first time there was a catch and possession limit put on yellow perch. Yellow perch daily catch and possession limits were established at 25 fish, except for Long Point Bay (50 fish), defined as the area inside of a line drawn from tip of Long Point to Peacock Point. In 2004, the limit was changed to 50 perch basin-wide.

2.2 Performance of Fisheries and Changes in Regulations

The commercial walleye fishery was able to harvest the quota set for the Niagara cap area each year (Table 2.2-1). The overall rehabilitation zone quota was achieved in the first year, but harvest declined successively over the 5 years, reaching the lowest level of 40,983 lbs in 2004.
A strong recovery of yellow perch during the rehabilitation period caused a major increase in the supply of fish, as the 1998 year class entered the fishery as 3 year olds in 2001. The quota remained at 40,000 lbs in 2001, but was increased to 80,000 lbs for 2002. Harvest exceeded quota, in 2002. For 2003 and 2004, the quota was increased for the gillnet fishery to 105,000 lbs with the provision that only 15,000 lbs of this harvest could be taken in the far east end in a new "Perch Cap" area (Figure 2.1-1). Starting in 2003, as mentioned in Section 1.3 (Smelt Harvest Mangement), an cap of 15,000 lbs was made for the bycatch harvest of yellow perch in smelt trawls. In 2003, 8,671 lbs and in 2004, 796 lbs of the 15,000 lb cap were used.

The Inner Bay hoop and seine fishery had an annual yellow perch quota of 26,758 lbs. and harvested most of it each year (Table 2.2-1).

The smelt fishery was not regulated under the Rehabilitation Plan. It was already regulated in order to limit harvest from the basin, as described in Section 1.3. Actual smelt harvests have been much lower than allowed by the smelt cap.

The recreational fishery was surveyed from June to August, 2003, and the survey provided estimates of angler harvest of yellow perch (52,503 lbs), smallmouth bass (43,363 lbs) and walleye (11,527 lbs, Table 2.2-2). Two fishing tournaments held at Port Colborne harvested 2,523 and 5,012 lbs of walleye. The recovery of the yellow perch fishery in the western part of the basin caused increased fishing for yellow perch in winter of 2003 and 2004. A winter creel survey conducted in 2004 produced a harvest estimate of 65,076 lbs of yellow perch (Table 2.2-2) (Arnold 2004b).

In 2003, the harvest in the yellow perch fishery was shared between commercial (110,151 Rehabilitation Zone + 24,398 Inner Bay = 134,549 lbs) and recreational (52,503 (summer) + 65,076 (winter) = 117,579 lbs) fisheries in a 53/47% split.

The walleye fishery was shared between commercial (53,287 lbs) and recreational (11,527 (summer) + 7,535 (tournaments) = 19,062 lbs) in a 74/26% split.

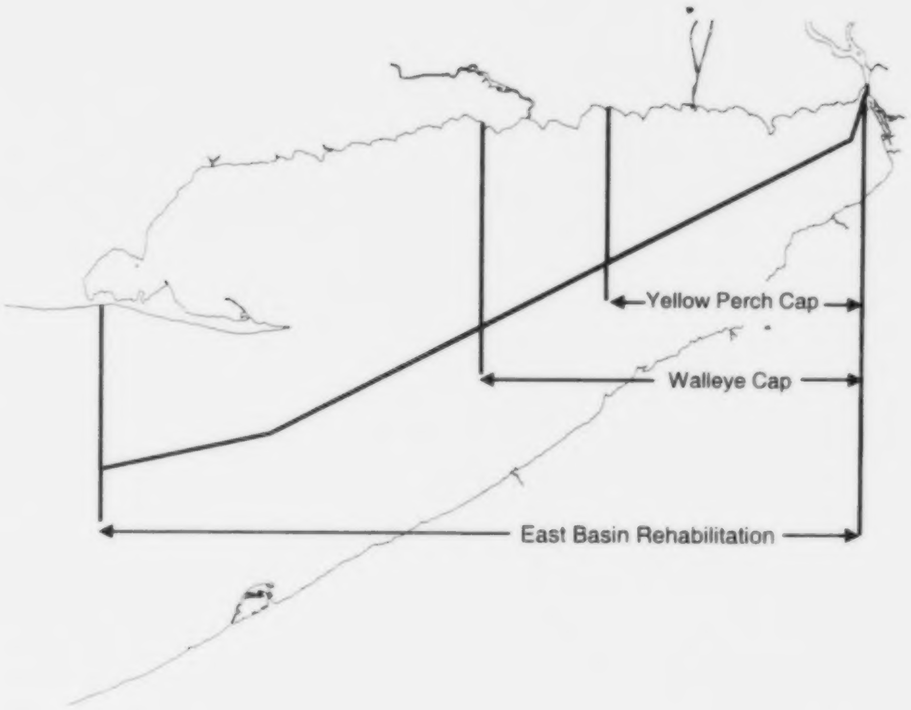
Yellow Perch Cap
Walleye Cap
East Basin Rehabilitation

Figure 2.1-1. The Eastern Basin Rehabilitation Zone defined for the period 2000-2004, had two areas with additional regulation within it: a walleye cap area (2000-2004) and a shorter term perch cap area (2003-2004).

Table 2.2-1. Summary of eastern basin commercial harvest quotas and harvest data in lbs. for walleye, yellow perch, rainbow smelt and Northern pike, 2000-2004.

	Walleye (Figure 2.1-1)					
	Rehabilitation Zone		Niagara Cap Area		Non Cap Area	
Year	Quota	Harvest	Quota	Harvest	Quota	Harvest
2000	192,000	188,885	31,050	28,754	160,000	160,131
2001	192,000	912,33	31,050	28,962	160,000	62,271
2002	192,000	738,44	31,050	23,336	160,000	50,508
2003	192,000	532,87	31,050	28,942	160,000	24,345
2004	192,000	409,83	31,050	28,031	160,000	12,952

	Yellow Perch (Figure 2.1-1)		GN =	Gill net				
	Non Cap Area		Eastern Cap Area		Trawl Bycatch		Total	Total
	GN Quota	GN Harvest	Quota	Harvest	Quota	Harvest	Quota	Harvest
2000	40,000	37206					40,000	37,206
2001	40,000	41,837					40,000	41,837
2002	80,000	99,697					80,000	99,697
2003	90,000	90,728	15,000	10,752	15,000	8,671	120,000	110,151
2004	90,000	97,418	15,000	7,637	15,000	796	120,000	105,851

Note: Eastern Cap and Trawl Bycatch established in 2003

	OE 4 & 5 Fishery (Figure 1.1-2)		Inner Bay Hoop and Seine Fishery (Figure 1.1-1)			
	Rainbow Smelt		Yellow Perch		Northern Pike	
	Cap (quota)	Harvest	Quota	Harvest	Quota	Harvest
2000	5,500,000	2,310,388	26,758	10,541	27,000	19,081
2001	5,500,000	2,999,303	26,758	20,109	27,000	17,572
2002	5,500,000	4,360,532	26,758	26,763	27,000	11,534
2003	6,898,000	3,907,564	26,758	24,398	27,000	15,131
2004	8,048,699	3,709,015	26,758	18,931	27,000	9,279

Table 2.2-2. Data from the 2003 summer recreational fishery (June -August) in the eastern basin of Long Point, tournament walleye fisheries (Arnold 2004a) and the 2004 winter ice fishery in Inner Long Point Bay (Arnold 2004b).

Species	Target Effort (Rod-hr)	Catch Number	Harvest Number	Harvest Weight lbs	% of Total Harvest	Target CPUE	Observed CPUE
Yellow Perch	66,380	118,408	86,782	52,503	62.4	1.80	0.5
Smallmouth Bass	82,121	94,170	24,887	43,363	17.9	0.78	0.44
White Bass	8,094	19,080	13,345		9.6	1.80	0.05
Largemouth Bass	26,332	13,518	781		0.6	0.44	0.07
Walleye	30,876	3,231	2,641	11,527	1.9	0.12	0.03
Northern Pike	4,749	1,086	156		0.1	0.11	0.01
Rainbow Trout	9,898	806	784		0.6	0.08	0.003
Coho Salmon	2,201	246	246		0.2	0.09	0.001
Lake Trout	159	244	32		0	1.54	0.002
Chinook Salmon	3,776	210	210		0.2	0.06	0
Walleye (Can Am Tournament)			374	2523			
Walleye (444 Tournament)			823	5012			
Winter Fishery							
Yellow Perch		535399	236051	65076			
Northern Pike		385	295				
Mudpuppy		2484	133				
Total Yellow Perch			322,833	117579			
Total Walleye			3,838	19062			

NOTES:

Observed CPUEs (fish/rd-hr) were calculated from observed catch/observed effort values from all anglers. Target CPUEs (fish/rd-hr) were calculated from targeted observed catch/ targeted observed effort values from anglers targeting specific species.

2.3 Economic Values of the Fisheries

The commercial fishery has been valued following the methodology used in the 1985 Canadian Great Lakes fishery by Talhelm (1988). The dockside fish prices (OMNR 2004, Table 2.3-1) were used to generate a dockside fish value of the 2003 harvest to individual licence-holders of $1,429,533. This is estimated to have a retail value of $4,603,161 (multiplier 3.22) and have an economic impact (multiplier 2.0) in the lakeshore communities of $9,206,323.

The recreational fishery has been valued using the summer fishery of 2003, and the winter creel fishery of 2004 (Table 2.3-1) (Wright 2005). The expenditures/trip was reported as $204.62 for the summer anglers, and when multiplied by 26,031 trips, the total expenditures are $5,326,463.22. Anglers reported expenditures of $286.91/year on their boats during the year. The total annual expenditure was estimated as $12,795,017.43

Table 2.3-1. Valuation of fisheries and estimated economic impact in 2003 and winter ice fishing in 2004. Confidence intervals of harvest are propogated to economic values in table. (Boat years is the number of trips divided by the average number of trips per boat annually)

		Harvest 2003(lbs)	Landed Value/lb	Total Landed Value	Retail Sales	Economic Activity
Commercial	Walleye	53,287	$2.16	$115,092.36	$370,597.40	$741,194.79
	Walleye Quota	192,000	$2.16	$414,692.76	$1,335,310.67	$2,670,621.35
	Yellow Perch	125,282	$3.00	$375,407.43	$1,208,811.93	$2,417,623.85
	Yellow Perch Quota	157,000	$3.00	$470,450.40	$1,514,850.28	$3,029,700.55
	Smelt	3,709,015	$0.23	$851,218.56	$2,740,923.78	$5,481,847.55
	Smelt Quota	8,048,699	$0.23	$1,847,175.60	$5,947,905.43	$11,895,810.86
	Northern Pike	24,398	$0.72	$17,664.95	$56,881.15	$1,13,762.30
	Northern Pike Quota	26,758	$0.72	$19,373.67	$62,383.22	$1,24,766.44
	Inner Bay (other)	117,068	$0.60	$70,170.00	$225,947.40	$451,894.80
	Total Harvest	4,029,050		$1,429,553.31	$4,603,161.65	$9,206,323.29
	Total Quota	12,453,507		$4,181,245.73	$13,463,611.25	$26,927,222.49
Recreational	Walleye	19,062				
	Yellow Perch	117,579				
	Smallmouth Bass	43,363				
	Total	180,005				
	Anglers (Summer fishery)	26,031				
	Expenditure/trip	$204.62				$5,326,463.22
	Boat Cost/trip	$286.91				$7,468,554.21
	Total					$12,795,017.43

3.0 Status of Stocks

3.1 Walleye

East Basin Stock Structure

In eastern Lake Erie, spawning walleye have been observed in both rivers and at shoals in the lake (Figure 3.1-1). Goodyear (1982) noted the historical record of Big Creek as a walleye spawning area and the Inner Bay as juvenile habitat. The Grand River continues to support resident walleye along its length and to attract adult walleye from the lake for spawning (MNR surveys 2000-2004). Spawning activity on shoals along the north shore has not been documented (by egg deposition) but concentrations of mature fish are found during spawning season (MNR surveys 2000-2004). Concentrations of fish were found associated with rocky points on either side of the Grand River confluence in spring, where the habitat was favoured by the warmer waters of the river plume. Other shoals were investigated further to the east and small numbers of mature fish were found. In New York waters, Goodyear (1982) identified a large shoal upstream of the entrance to the Niagara River as a spawning site, and shoreline substrates at Lackawanna (mouth of Smokes Creek) have been identified as a spawning area (Einhouse, unpubl. data)[3]. Farther west, walleye have been documented to spawn at three sites, and concentrations are known to occur at other sites. Walleye were sucessfully re-established to Cattaraugus Creek from a Maumee River, Ohio source. In Pennsylvania, a spawning concentration was recorded at Walnut Creek (R. Kenyon, PA. Fish & Boat Comm., Fairview, PA, USA, pers. comm.).

In New York, larval walleye have been collected in plankton tow nets nearshore, and young of the year have been collected in seine hauls. In Ontario waters, young-of-the-year (YOY) walleye have only been found in the Grand River. Yearling walleye are more extensively distributed throughout the basin.

Tagging studies conducted in New York have provided strong evidence of stock structure in walleye (Wolfert and Van Meter 1978, Einhouse and Haas 1995). Walleye tagged at shoals in NY in the 1970s and 1990s dispersed primarily within eastern Lake Erie, but some entered the central basin (Einhouse and Haas 1995). Examination of the long term dataset to present day indicates that these fish display a high degree of fidelity to their original tagging site, presumably as a spawning area (Einhouse unpubl. data). These findings are supported by more recent genetic analysis of stock structure in Lake Erie by RNA and/or DNA analysis (Stepien 1995, Merkur and Woodruff 1996, McParland *et al.* 1999, Gatt *et al.* 2003), which describes the level of reproductive isolation between stocks.

A recent genetic analysis of all Lake Erie aggregations (Wilson 2003; Schaefer and Wilson 2002) has identified two eastern basin groups that can be distinguished to varying degrees from each other and from western stocks. Grand River fish are most reliably identified in such analysis, followed by those from spawning shoals in New York. A third group consisting of walleye which aggregate on lake shoals in Ontario waters are less distinct genetically and analysis suggests that these fish have mixed ancestry from eastern and western stocks. A successful introduction of western (Maumee River strain) walleye into Cattaraugus Creek (NY) resulted in a fourth source of eastern basin fish that are not readily distinguishable from the western parent stock. The genetic characterization or signature for these groups has been used to identify which stocks are contributing to a particular fishery in a given area.

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[3] Refered to as Eastern Shoals, New York in this document

Contribution to Fisheries

Tournament fishing for walleye in the Port Colborne area in 1996 produced catches composed of fish characterized as originating from New York shoals (16%), Grand River, Ontario (16%), and the western basin (63%) (Gatt *et al.* 2003). Analyses of more recent tournaments indicate that the contribution of fish from eastern stocks has increased (Wilson 2003 and Wilson unpubl. data) but because the tournament occurs within a small time period, the results should be interpreted with caution, as they may not represent the entirety of the fish community. (Figure 3.1-2).

The composition of the commercial harvest has also changed between 1995 and the present. In the mid 1990s the east basin harvest included large contributions (>70%) from relatively strong western stocks (Gatt *et al.* 2003). More recent analysis shows that the commercial harvest between 1999 and 2003 had smaller contributions from relatively weaker western origin stocks (16-26%) and small but increasing contributions from eastern basin stocks (Eastern Shoals, New York and Grand river origin; 10-30%). A proportion of the fish could not be positively sourced and were characterized as "mixed origin" (Figure 3.1-3). "Mixed origin" is the designation given to spawning fish from eastern basin north shore shoals; however, it is possible some of these fish are of western origin (C. Wilson, MNR, Peterborough, ON, pers. comm.).

Most of the commercial catch samples from the 1995 analysis came from fisheries in the western end of the eastern basin (i.e., Long Point Bay area). It was suggested that western basin migrants, and to a lesser extent Grand River stocks, contributed more to the western part of the basin (i.e. OE 4) while New York stocks contributed to areas further east (Gatt *et al.* 2003). Spatially divided samples from 1999 and 2000 were assigned based on categories similar to those used in 1995 (Grand River, Eastern shoals, New York, West basin and western Grand River-Ohio). While the overall contributions of western stocks to the commercial fisheries have declined since 1995, there is still evidence of this west-east difference in stock distributions; there were more NY walleye in the fisheries from the eastern part of the east basin and slightly more western basin fish in the Port Dover part of the east basin in 1999/2000 (Figure 3.1-4).

Assessment

In 2003 and 2004, the number of small walleye (age 1-2 yrs) in catches from the OMNR's Long Point Bay index fishing survey increased considerably. In 2004, commercial fishers noted that larger than usual numbers of yearling walleye were appearing in nets targeting yellow perch. Analysis indicates that the majority of these young walleye were of eastern origin, primarily from Cattaraugus Creek, New York shoals, eastern shoals (Ontario), and mixed ancestry (eastern origin) (Figure 3.1-5). Grand River (Ontario) fish contributed the least to the sample. Grand River fish are more common in the fisheries as large fish. MacDougall (unpubl. data) suggests that most of the Grand River walleye stock may be resident in the river to age 2 before entering the lake.

Data from an annual index netting survey in September (OMNR and OCFA, unpubl.) describes the spatial distribution of yearling and older walleye in the eastern basin (Figure 3.1-6). Across survey years 1998-2004, the highest densities were found in the eastern half of the basin. Western sets included large numbers of zero or single fish catches. Commercial harvest data from the years 1994-99 when harvest was not limited spatially were mapped for comparison (Figure 3.1-7). These data indicate that there were three areas contributing the most fish: eastern waters (OE 5), Long Point Bay and the extreme western area (Grids 161 and 188). Survey data from New York waters shows a pattern of higher density along the NY shoreline (NYDEC 2004) that is consistent with the density pattern of tagged fish recaptures reported by Einhouse and Haas (1995). The commercial walleye fishery during the rehabilitation period was able to harvest the allocation in the walleye cap area each year, but did not harvest the additional fish in the western part of the zone, after the first year (Section 2.0). The much lower abundance of fish in that area of the lake may be showing the stronger dependence of this part of the fishery on western origin stocks.

A monitoring program focused on juvenile and adult yellow perch and smallmouth bass in nearshore waters of Long Point Bay tracked the decline of walleye in the 1990s (Ryan *et al.* 1999) and may now be describing a recovery. A substantial percentage of age 1 walleye collected in 2004 from the index netting program and from the commercial fishery originated from eastern basin sources (Figure 3.1-5). A program of standardized electrofishing is being developed for the Grand River (MacDougall, unpubl. data).

The partnership index fishing program describes trends in walleye abundance across the basin (Figure 3.1-8). Over the entire area, the abundance of walleye was lower after 1997 than recorded previously. Within the rehabilitation zone, the Niagara cap area shows a small increase after 1997, while the western part of the zone shows a decrease. This is consistent with the spatial pattern described earlier, being based on the same data, but is also consistent with the performance of the walleye commercial fishery. The recreational fishery for walleye in Ontario waters varies spatially. Angler diary CPUE (Figure 3.1-9) was highest (1998-2004) in the Port Colborne area, and lower in all other areas of the rehabilitation zone. The pattern in the Nanticoke area fishery is most similar to that shown for the central basin fishery. This should occur if both fisheries are primarily dependent on western basin fish. Assessment data from New York (NYDEC 2004) showed comparatively little change in angler CPUE from the mid-1990s to the presentand a walleye abundance index from NYDEC gill nets showed the same pattern of variation as the Ontario data from the walleye cap area.

A total of 3230 walleye were caught in the recreational fishery in 2003 (Arnold 2004). Most walleye were caught by anglers fishing out of the Grand River (38.7%) and Port Colborne (45.2%). This distribution was consistent with the pattern in the walleye commercial fishery. The commercial fishery harvested the total for the Niagara cap area, but fell short of the quota in the rest of the rehabilitation zone (Section 2).

In 1993, a CAGEAN catch-at-age model was developed to estimate the abundance of walleye in the east basin (Einhouse *et al.* 1993). This model incorporated catch and effort data from Ontario commercial fisheries, and New York and Pennsylvania recreational fisheries from the years 1985-1991. Natural mortality in this model was assumed to be 0.17. This model estimated that the abundance of walleye was as high as 3.5-4.5 million fish from 1985-1988, then decreased to around 1.5 million fish by 1991 (Figure 3.1-10). In 2000, the Lake Erie Walleye Task Group moved away from using the CAGEAN model to estimate lakewide walleye abundance due to concerns about the model's accuracy (WTG 2001). The task group began using an ADMB model which was able to incorporate survey data in addition to catch and effort data. Recently, an ADMB east basin walleye catch-at-age model was developed for years 1996-2004, using catch and effort data from Ontario, New York and Pennsylvania fisheries, as well as Ontario and New York survey data, and a constant natural mortality rate of 0.16 (D. Einhouse and K. Kayle unpubl.). This model indicates that the abundance of fish has recently ranged from 0.62 to 1.9 million fish, increasing slightly in the last year to 1 million fish (Figure 3.1-10). Abundance values from the two models are not directly comparable due to different models and assumptions used in the abundance estimates. However, they do indicate that the abundance of walleye in the east basin was higher in 1985-1989, corresponding to yearswhen large numbers of fish from western stocks were present.

Walleye Status Indicators

Table 3.1-1 compares historic and current walleye status indicators from survey, commercial and catch-at-age analysis sources. Average indicators for the 1980s, 1990s and during the rehabilitation period (2000-2004) are presented.

Abundance indices presented are based on population estimates from 1996-2003 (Einhouse and Kayle, 2004) and Ontario partnership gillnet survey data collected in the eastern basin rehabilitation zone (1989-2004). In the former case, model data included Ontario commercial and partnership survey data, along with New York gillnet survey, and New York – Pennsylvania recreational harvest data. Mean walleye abundance (ages 2 and older) from catch-age analysis were comparable between the late 1990s (1.2 million average 96-99) and early 2000s (0.9 million average 2000-2003). Partnership index catches of age 2 and older walleye were comparable between the 1990s (1990-1999 average 1.6/km) and 2000s (2000-2004 average 1.8/km). Generally, walleye abundance in eastern Lake Erie overall appears stable, although fall walleye concentrations west of the Niagara cap area appear reduced from the time period of 1998-2004 compared to 1989-1995 (Figure 3.1-8).

Average total mortality (Z) estimates from catch-age analysis were different between the earlier (1996-1999 Z=0.29) and later (2000-2003 Z=0.39) time periods for walleye ages 2 and older (Einhouse and Kayle, 2004). Survival estimates were based on the abundance of walleye ages 3 and older that survived from the previous year. Mean survival estimates for the two periods were 75% and 68% respectively. Mortality estimates based on partnership survey data were derived for cohorts by linear regression with catch curves ($\log_e$(catch)) for ages 2 and older, with zero catches excluded. In addition, survival was estimated using the Chapman-Robson minimum variance unbiased approach (Everhart *et al.* 1975). Since the Chapman-Robson method is applied to age frequencies, catch rates (walleye/gang) were multiplied by 100 to perform the calculations. Results were relatively insensitive to the multiplier used, differing by 1% or less usually when a multiplier of 1000 was used. Table 3.1-1 provides ranges of mean total mortality (Z) for the 80s, 90s and 2000s time periods (0.28-0.35, 0.21-0.31, 0.34-0.61 respectively). The ranges are average mortalities derived using catch curve and the ChapmanRobson method. Representation of time periods by a cohort was assumed dependent on the temporal proximity of age 3 walleye. Survival rates from survey data were a function of Z. Survival rates over the 3 time periods based on survey catch rates of walleye ages 2 and older were 71-76%, 74-82%, and 54-71% respectively.

Exploitation rates derived from catch-age analysis (Einhouse and Kayle 2004) averaged 11% during the 1990s period (1996-1999) and later (2000-2003). Exploitation appeared variable within the latter period however, with estimates of 15, 8, 10 and 9% for 2000, 2001, 2002 and 2003 respectively.

The spawning stock size was considered to be represented by ages 3 and older since logistic regression of survey data indicated that female age at 50% maturity (spring) was 3.4 (based on fall value of 2.4). Assuming recruits to fisheries are two years old, stock to recruit ratios were derived, with a two year lag recognized between spawning and recruitment. These ratios were equal from 1996-1999 and 2000-2003 based on catch-age analysis (5), but appeared different between time periods when referring to survey data (3 vs 13). The later ratio was based only on spawner abundance in years 2000-2002 however, limiting it's utility. Inclusion of the 2003 spawning stock in the future would likely lower the ratio considerably, if age 2 abundance in 2005 is high.

Average recruitment of age 2 walleye based on catch-age analysis may be higher post 2000 (322,000) compared to the latter half of the previous decade (205,000) (Einhouse and Kayle 2004). Partnership survey data indicates age 2 recruitment to be comparable between the two decades (0.49 vs 0.43 walleye/km). Yearling walleye were caught in the east basin Partnership survey infrequently compared to older age groups, with the recent exceptions being the 2003 year class, and to a lesser degree, the 2001 year class (Figure 3.1-8). Mean yearling walleye abundance from 2000-2004 (0.14/km) was double that of the 1990s (0.07/km).

Although inter-annual variation in walleye growth was apparent, clearly discernable trends in length, weight or condition at age were not evident since the inception of the Partnership survey in 1989.

Mean age of the east basin walleye population based on Partnership survey data during the recent period (2000-2004 mean=4.9) was similar to the1990s (mean=4.3). Although these values imply relative stability, they are influenced by singular recruitment events.

The mean age of walleye harvested by Ontario's commercial fishery in OE4 and OE5 combined appeared stable over time at 6.4 (1993-1999) and 6.3 (2000-2004). Compared to age at 50% maturity, the mean age composition of the harvest produced consistent Abrosov (1967) values of 3.4 and 3.3 over consecutive time periods. The difference between the mean age of commercial harvest and the onset of sexual maturity is considered an indicator of spawning frequency. While the values calculated here exceed Abrosov's (1967) suggested values of 1.0-1.5 for pike-perch, the degree to which all conditions support recruitment should be taken into consideration. The fact that yearling walleye were generally not abundant in survey gillnets compared to older age groups, implies that conditions for local recruitment were often less than optimal.

Individual transferable quotas (ITQ) were introduced to Lake Erie in 1984 (section 1.3). Ontario's commercial walleye harvest from OE 4 & OE5 combined decreased over three time periods, averaging 237,000 lbs (1984-1989); 249, 000 lbs (1990-1999) and 114,000 lbs (2000-2004), however 2000 – 2004 was the result of decreased quota under the rehabilitation plan. The spatial distribution of walleye harvest has changed over time within the OE 4-OE 5 area. The proportion of years during which OE 5 walleye harvest exceeded OE 4 was 0% from 1984 to 1989, 10% from 1990 to 1999 and 40% from 2000 to 2004, with an apparent shift occurring in 1999. This change in the spatial distribution of harvest within eastern Lake Erie reflects to some degree the declining abundance of walleye in the west and central basin during the 1990s.

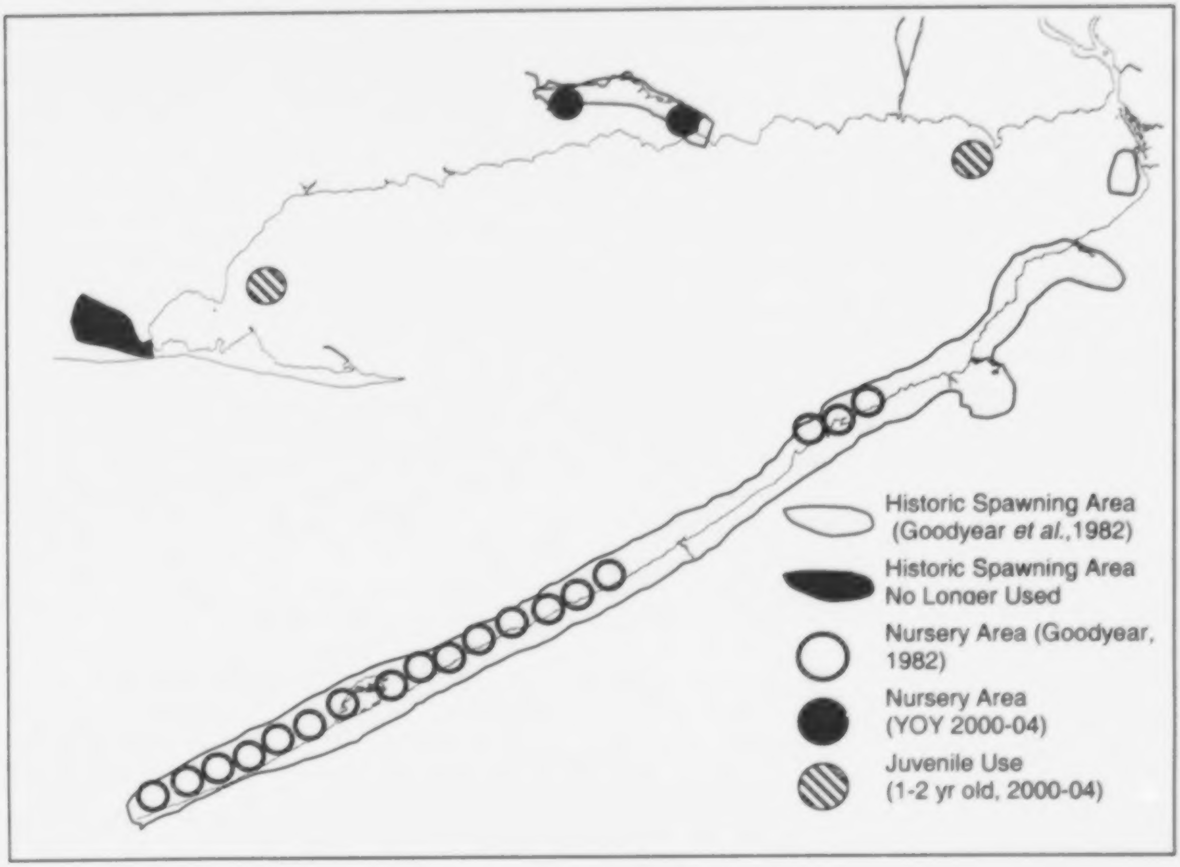

Historic Spawning Area (Goodyear *et al.*,1982)
Historic Spawning Area No Longer Used
Nursery Area (Goodyear, 1982)
Nursery Area (YOY 2000-04)
Juvenile Use (1-2 yr old, 2000-04)

Figure 3.1-1. The eastern basin of Lake Erie showing use by walleye for spawning and nursery habitat. Historic sites are reproduced from Goodyear *et al*. 1982.

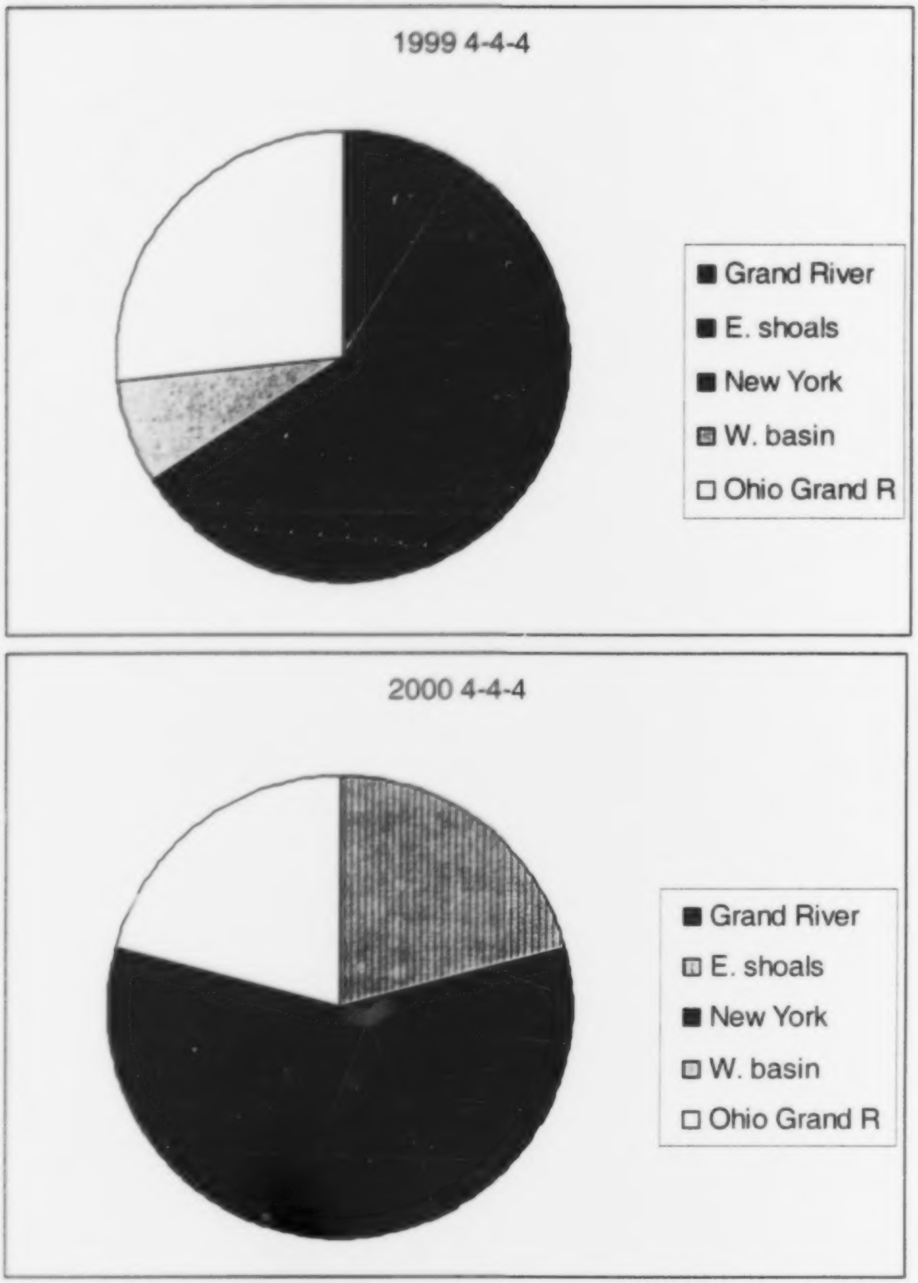


Figure 3.1-2. A mixed stock analysis of the Port Colborne tournament fishery as represented by the "4-4-4" derby in 1999 and 2000.

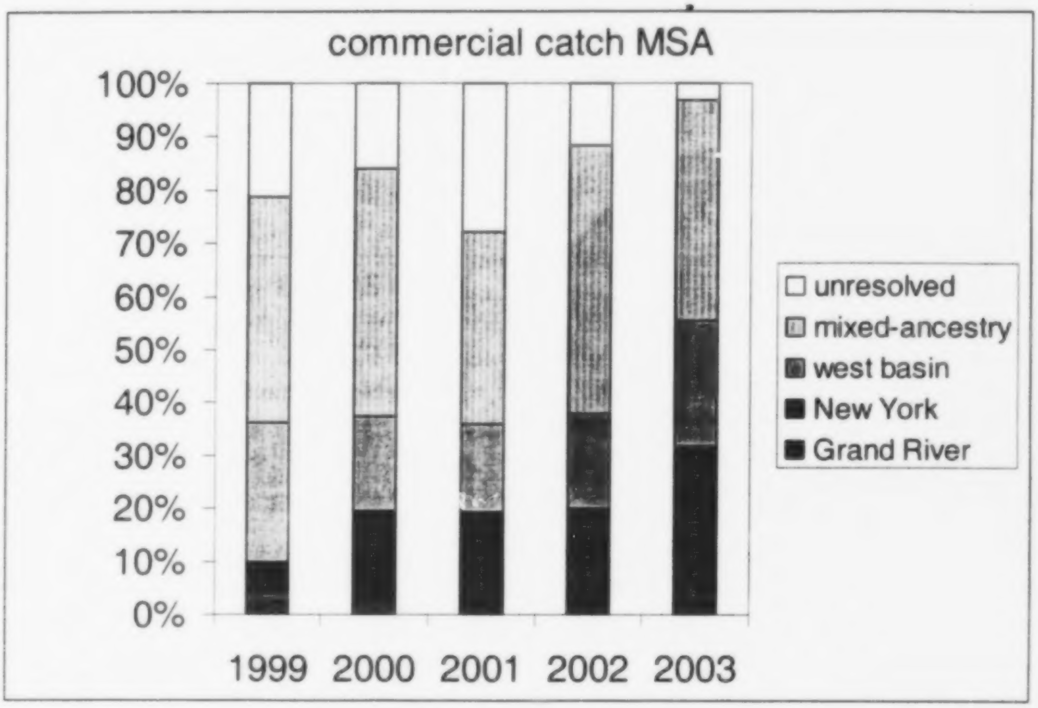
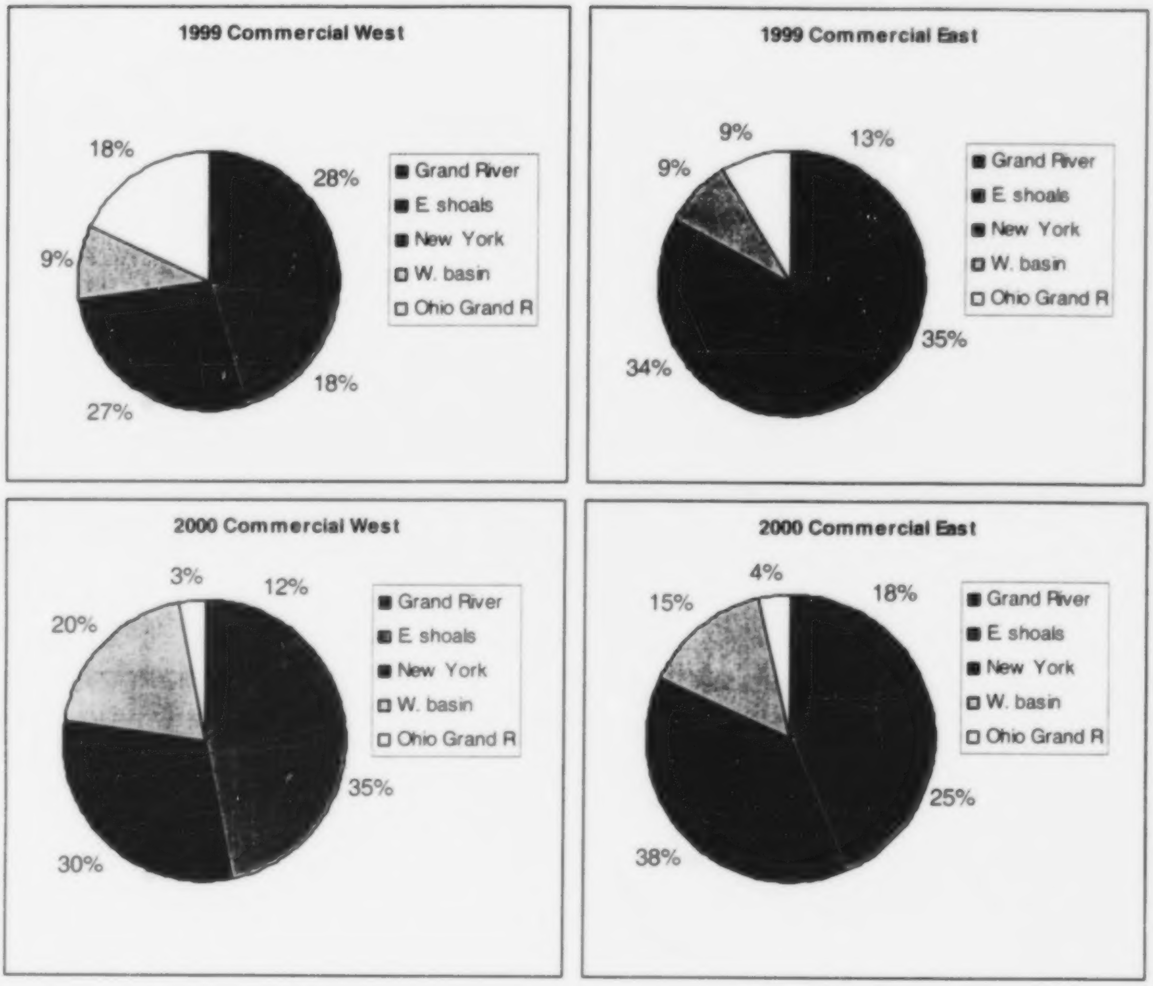


Figure 3.1-3. A mixed stock analysis of the east basin fishery catch, 1999-2003.



1999 Commercial West

1999 Commercial East

2000 Commercial West

2000 Commercial East

Figure 3.1-4. A mixed stock analysis of commercial fisheries from the Niagara Cap (Commercial East) and western zone of the eastern basin (Commercial West) during 1999 and 2000.

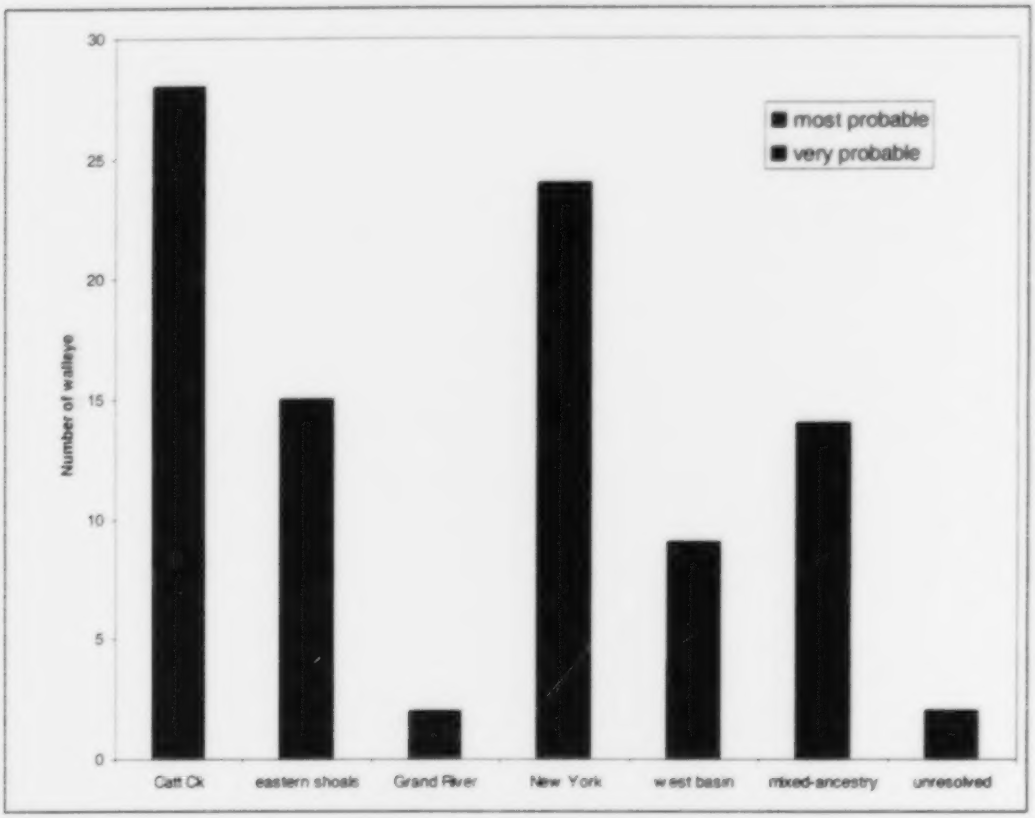


Figure 3.1-5. Origin assignments for juvenile walleye (≤ 2 yrs.) collected in Long Point Bay summer 2003 and 2004.

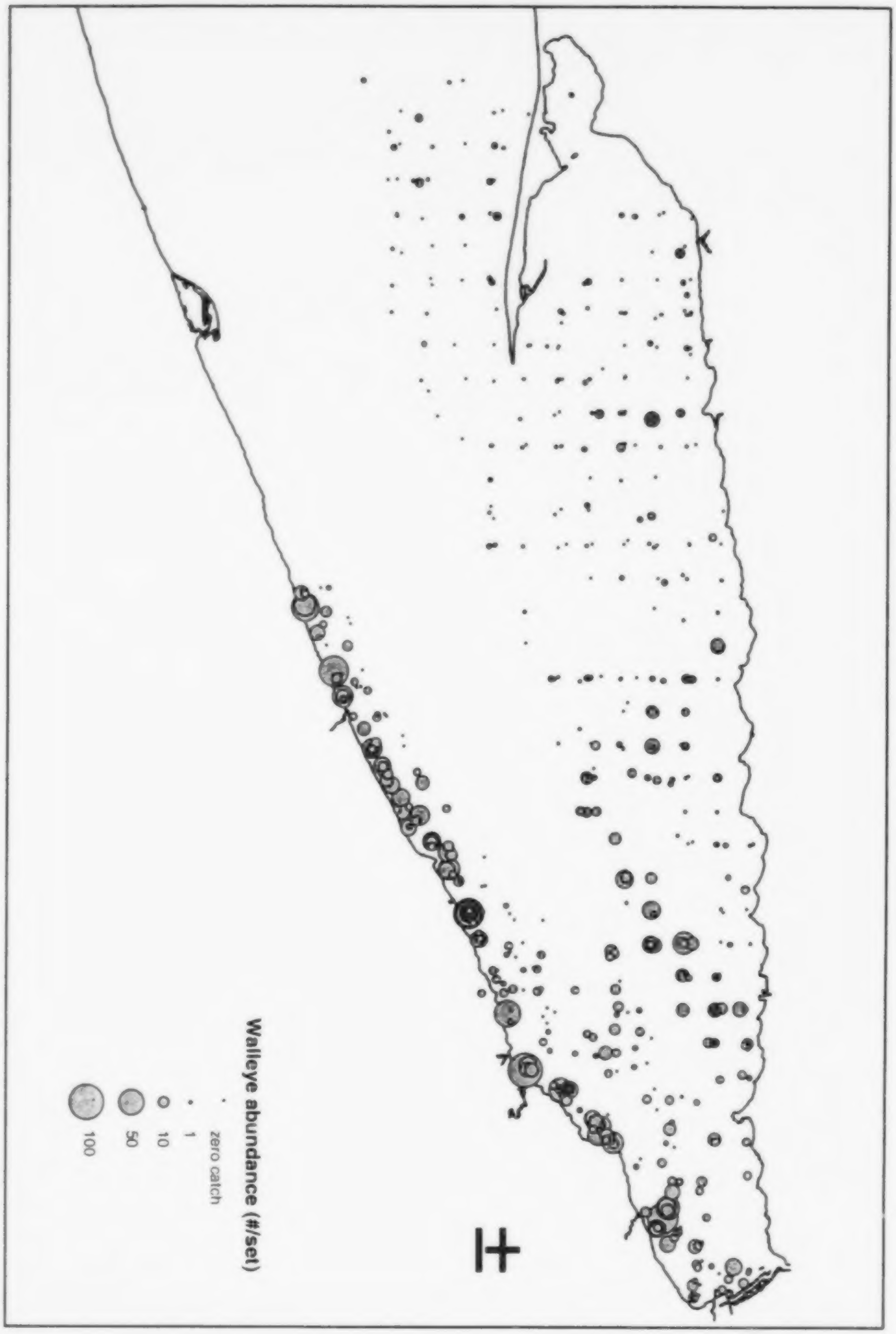

Walleye abundance (#/set)
zero catch
1
10
50
100

Figure 3.1-6. Spatial distribution of juvenile and older walleye as shown by catch data from the Partnership Index Fishing Survey (1998-2003) and NYDEC walleye gillnet index between 1998 and 2004.

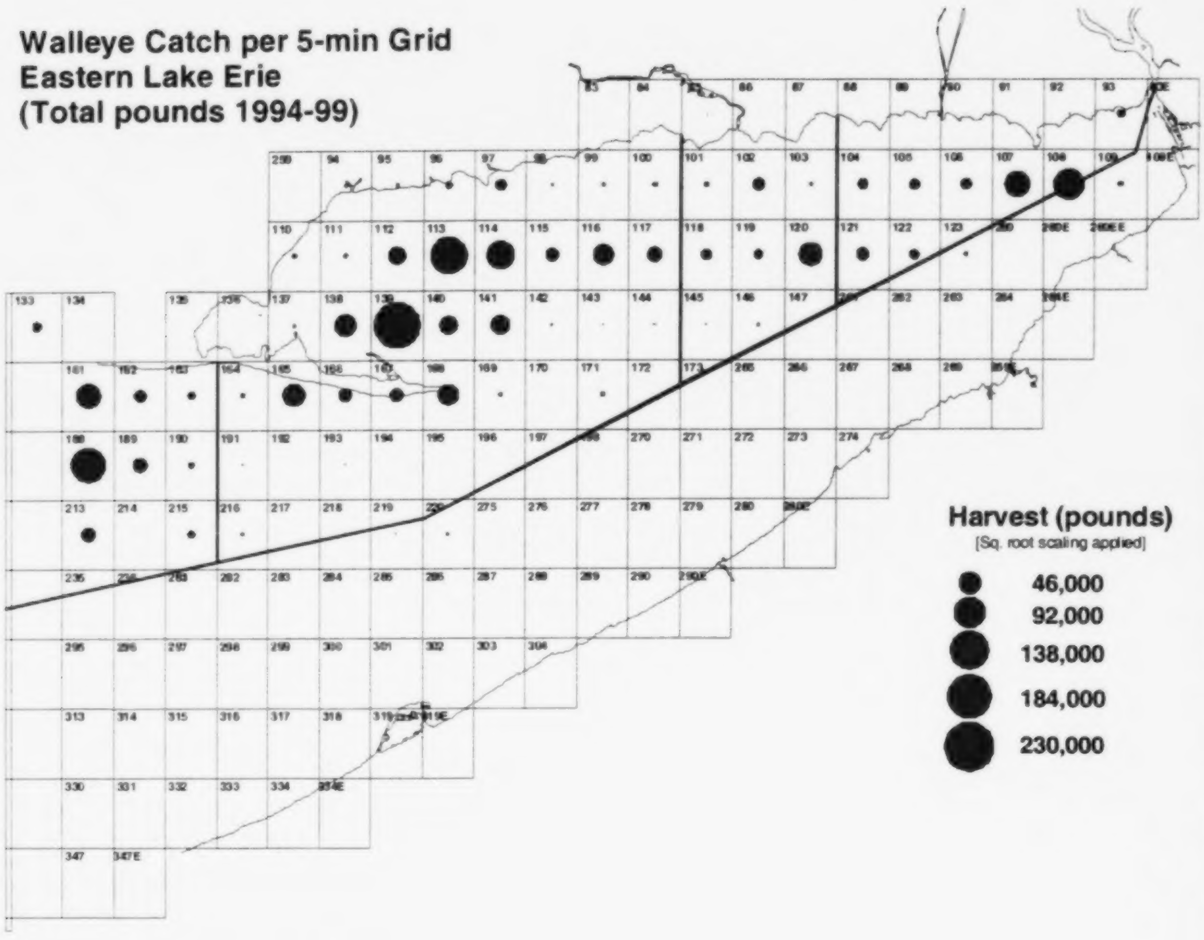

Walleye Catch per 5-min Grid
Eastern Lake Erie
(Total pounds 1994-99)
Harvest (pounds)
[Sq. root scaling applied]
46,000
92,000
138,000
184,000
230,000

Figure 3.1-7. Commercial harvest of walleye by grid for years 1994-99.

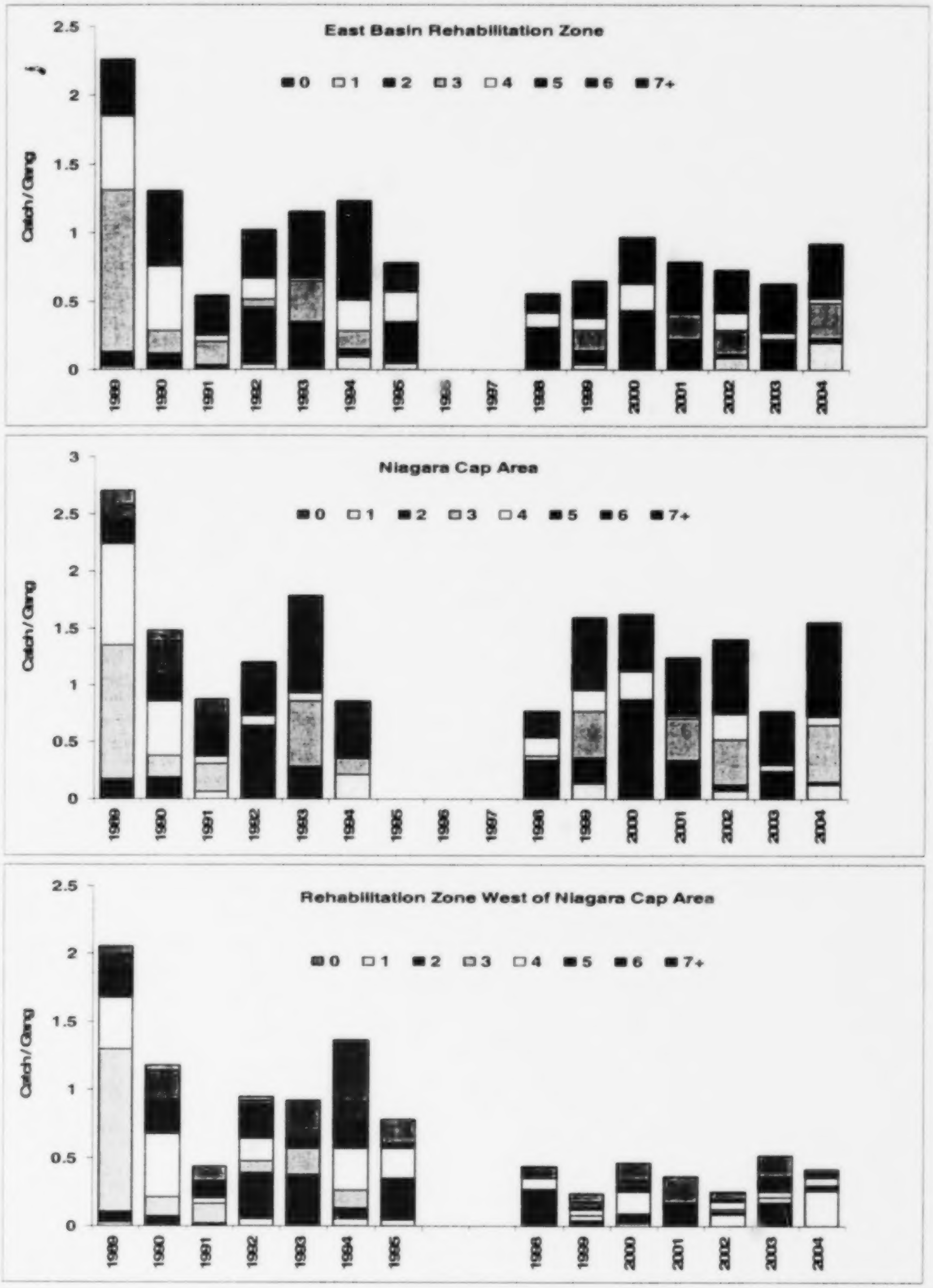
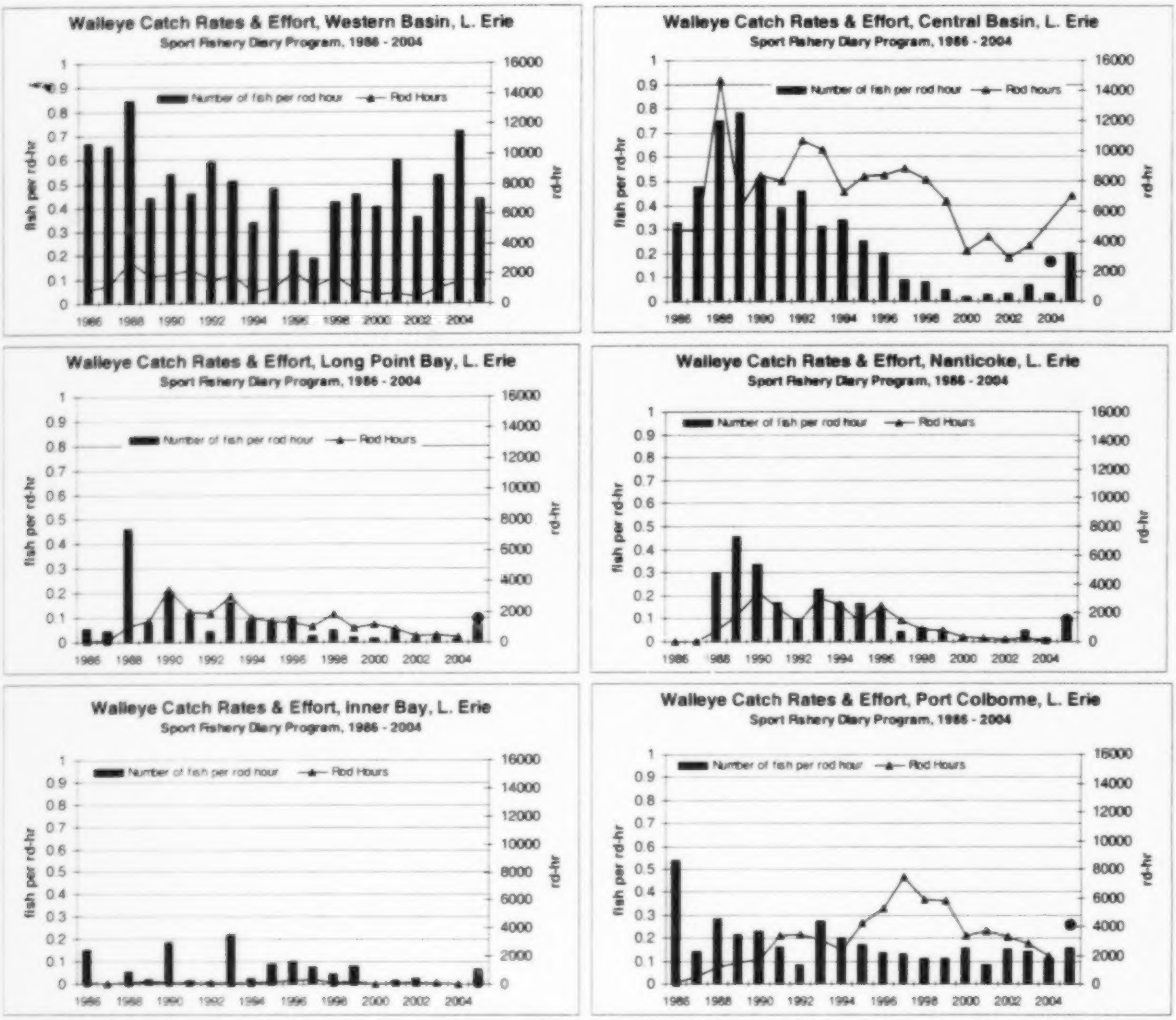


Figure 3.1-8. Walleye catch per effort by age class and total for the eastern rehabilitation zone from partnership index fishing. Upper figure represents entire zone, middle figure represents Niagara Cap Area, and bottom figure represents remainder of zone to west. Study was not completed in 1996 and 1997. Low sample size in 1995. Ages 7 and older pooled.



Walleye Catch Rates & Effort, Western Basin, L. Erie
Sport Fishery Diary Program, 1986 - 2004

Walleye Catch Rates & Effort, Central Basin, L. Erie
Sport Fishery Diary Program, 1986 - 2004

Walleye Catch Rates & Effort, Long Point Bay, L. Erie
Sport Fishery Diary Program, 1986 - 2004

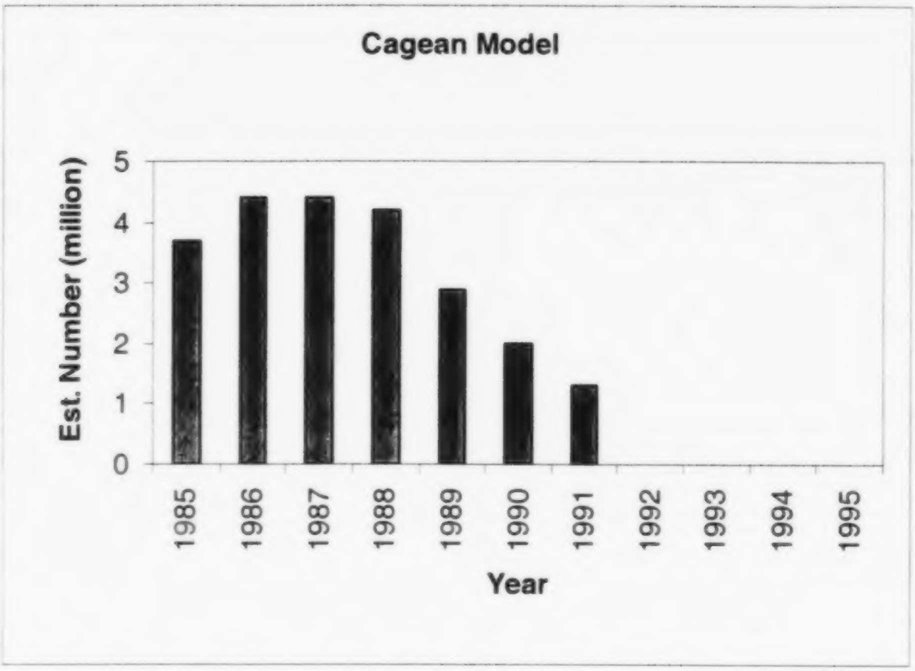
Walleye Catch Rates & Effort, Nanticoke, L. Erie
Sport Fishery Diary Program, 1986 - 2004

Walleye Catch Rates & Effort, Inner Bay, L. Erie
Sport Fishery Diary Program, 1986 - 2004

Walleye Catch Rates & Effort, Port Colborne, L. Erie
Sport Fishery Diary Program, 1986 - 2004

Number of fish per rod hour
Rod Hours
fish per rd-hr
rd-hr
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2000
4000
6000
8000
10000
12000
14000
16000
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004

Figure 3.1-9. Observation of angler CPUE and sample effort from angler diary participants targeting walleye, by area (1986-2004). Last column in graphs denotes average 1990-2003.



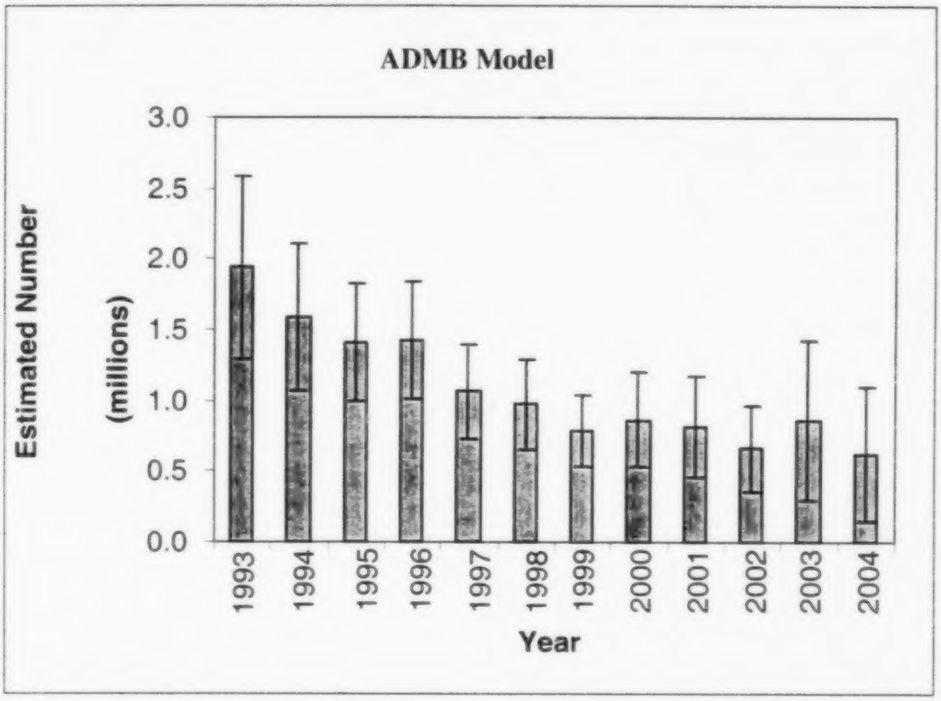


Figure 3.1-10. Estimates of walleye population size (age 2+) in eastern Lake Erie as reconstructed by catch at age analysis by Einhouse *et al*. (1993; 1985-91 data, Cagean Model) and Einhouse (unpubl.; 1996-2003 data, ADMB Model).

Table 3.1-1. Walleye status indicators based on survey and fishery data collected during the 1980's, 1990's and since 2000.

Indicator	**1980s**	**1990s**	**2000s**	**Comments / Possible Cause**
Abundance CATCH-AT-AGE ANALYSIS (Einhouse)		1.2 million	0.9 million	
Abundance - CPE PARTNERSHIP INDEX 2+ (#/km) REHAB ZONE	5.3	1.8	2.1	1980's value is one year 198
Total Mortality Z CATCH-AT-AGE ANALYSIS 2-11		0.29	0.39	Einhouse and Kayle unpubl. 2004
Total Mortality Z PARTNERSHIP INDEX 2+	0.28 - 0.34	0.22 - 0.32	0.44 - 0.73	time period for year class ba on age 3
% Survival CATCH-AT-AGE ANALYSIS 2+		75	68	Einhouse and Kayle unpubl. 2004
% Survival PARTNERSHIP INDEX 2+	71 - 76	73 - 81	49 - 67	time period for year class ba on age 3
Exploitation Rate % CATCH-AGE ANALYSIS 2-11		11	11	
Stock 3+ : Recruitment Ratio (age 2) CATCH-AGE ANALYSIS		5	5	influence of NY stocks in recruits
Stock 3+ : Recruitment Ratio (age 2) PARTNERSHIP REHAB ZONE		3	12	1996,1997 missing; 2000s based on 2000 and 2001
Recruitment CATCH-AT-AGE ANALYSIS (age 2) (Einhouse)		205,354	322,134	
Recruitment PARTNERSHIP REHAB ZONE (age 1) (#/km)		0.07	0.06	
Recruitment PARTNERSHIP REHAB ZONE (age 2) (#/km)		0.49	0.51	
Natural Mortality		0.17	0.17	Einhouse unpubl. (east basi mark-recapture).
Growth PARTNERSHIP AGES 2 - 5		stable		
Mean Age in Harvest OE 4 & OE 5		6.9	6.3	Catch-at-age analysis data s 1996-2003
Mean Age in Population PARTNERSHIP INDEX		4.4	5.0	
Age at 50% Maturity Male PARTNERSHIP INDEX REHAB ZONE		2.7		poor fit 1998-03
Age at 50% Maturity Female PARTNERSHIP INDEX REHAB ZONE		3.0		poor fit 1998-04
Abrosov Index (female)		3.9	3.3	
Commercial Yield (lbs) Ont. Statistical Districts OE 4 & OE 5	145,579	249,391	130,359	

Note: Total mortality and survival estimates from gillnet surveys are means for year classes 1984-1986; 1987-1996; 1997-1999 for the 3 periods

Total mortality estimates from survey data are presented as a range using catch curve analysis and Chapman-Robson approach (Everhart et al. 1975)

3.2 Yellow Perch

East Basin Stock Structure

Although spawning has been observed on sand, rock and a variety of other substrates, yellow perch prefer to spawn amongst rooted aquatic plants in shallow bays (Figure 3.2-1) in eastern Lake Erie. Spawning is widely distributed in the Long Point Bay area, including bays along Long Point, Inner Bay and areas with macrophytes in the eastern part of the Bay. Larval and juvenile perch have been documented throughout this area. Spawning and nursery habitat is more limited to the east. Juvenile perch were recorded in part of the Sandusk Creek mouth coastal wetland, in Port Colborne Harbour and in the bay on the east side of Point Abino. All of these areas provide submerged macrophyte habitat. The Grand River formerly supported yellow perch (Warrick, Wilfred Laurier University, Brantford, ON, pers. comm.) but they are now rarely found. Extensive electrofish surveys over the past 6 years have only observed adult yellow perch in the 7km stretch directly connected to the lake where they constituted <0.1 % of the total catch (LEMU unpublished data). Environmental conditions in the Grand River, Nanticoke Creek and the main stem of Sandusk Creek (highly trurbid with few submerged macrophytes) are unfavourable to yellow perch reproduction. Juvenile yellow perch in Long Point Bay either remain inshore (Inner Bay) or move offshore and occupy depths greater than 60 feet in winter. This movement is presumed to follow warmer water and would help them to avoid adverse winter environments nearshore

There is evidence of stock structure in the population of Lake Erie yellow perch, especially in the eastern half of the lake. Perch show differences in growth characteristics among basins, indicating effects of residency in different habitats (Henderson and Nepszy 1989). Meristic characteristics such as number of vertebrae may indicate that fish originate from different spawning areas because they are affected by environmental conditions during the incubation period for fish eggs (Helfman *et al.* 1997). MacCrimmon *et al.* (1983) showed that there were differences in meristic data (vertebrae/anal fin rays) between groups of fish examined from the three basins of Lake Erie. Commercially caught fish landed at Port Stanley differed from those landed at Erieau and from those landed at Wheatley, and perch collected from Long Point Bay differed from those landed at Port Stanley and ports farther west.

Craig (1987) stated that yellow perch exhibit "limited movement." Perch tagged during spawning between Port Dover and Nanticoke showed that most fish remained in Long Point Bay (MacGregor and Witzel 1987) (Figure 3.2-2). A histogram of movement distances showed that most fish recaptures occurred within 50 km and the modal distance was 6-10 kilometres. Spawning fish tagged in Inner Bay showed a broader distribution of recaptures, extending around Long Point (Figure 3.2-3). An earlier study showed recaptures from this area in mid-lake and along the south shore (Ferguson 1958) (Figure 3.2-4). In summary, recapture data indicates that contributions to fisheries of fish from spawning areas in Long Point Bay can be recognized through meristic data. The distribution of those fish extends around Long Point, south to Pennsylvania and east to the Grand River, but the highest density is in the vicinity of Long Point.

Data from the parntership index survey in September (OMNR and OCFA, unpubl.) describes the spatial distribution of yearling and older yellow perch (Figure 3.2-6). Across survey years 1998-2004, there were several higher density zones; the first near the west side of the base of Long Point and on the Pennsylvania Ridge, the second in Long Point Bay, and the third to the south-east and offshore of the Grand River. Commercial harvest data from the years 1994-99, when harvest was not limited spatially, were mapped for comparison (Figure 3.2-6). The pattern is a close match to that based on survey data. Survey data from New York waters also support the pattern of density in the eastern basin (NYDEC

2004). In overview, the thermal distribution of yellow perch seems to conform to the area of the lake bottom in epilimnetic waters, and the fishery focuses on concentrations of fish.

Genetic analysis of population structure is being conducted across the lake, and samples from the Eastern Basin have been included. Preliminary analysis indicates that there is evidence of stock structure in eastern Lake Erie (Ford and Stepien 2003).

Assessment

Management agencies for Lake Erie share their fisheries monitoring data and develop annual population assessments for yellow perch and other species. Data from Ontario, New York and Pennsylvania are pooled for Management Unit 4 (MU 4) (figure3.2-7) to estimate the number of yellow perch in eastern Lake Erie over time (Figure 3.2-8). Analysis indicates that MU 4 (corresponding roughly to the rehabilitation area plus opposite waters in US jurisdictions) has made a strong recovery and that the perch population in 2004 was around 11 million age 2 and older fish.

A monitoring program for juvenile and adult yellow perch in Long Point Bay documented an increase in yellow perch from 1986 to 1990, followed by a major decline from 1990 to 1999 (Figure 3.2-9) (Ryan *et al*. 1999). This decline was due to very poor year class strength as described by index bottom trawling in Inner Bay (Figure 3.2-10). The recovery of yellow perch abundance that began in 1999 was due to the immigration of the 1996 year class of yellow perch from other spawning areas in supporting MU3 and later by strong reproduction in Inner Bay in 1998.

The trend of a decline in yellow perch during the 1990s was seen basin-wide in the partnership index program (Ryan *et al*. 1999). Recent data show a basin-wide recovery to levels of abundance (#/set) greater than last seen in 1989. While these data are robust at a basin level (Figure 3.2-11), they are less reliable when smaller sets of data are examined and compared among years. The spatial pattern of the yellow perch fishery led to the addition of survey effort (extra sets) in the eastern part of the basin, and computation of a separate CPUE during the rehabilitation period. A recovery was evident in both the eastern and western parts of the basin. The 1998 year class that may have originated in Long Point Bay was a significant part of the increased abundance.

The recreational fishery for yellow perch in Ontario waters varies spatially as described in Section 2. Angler diary CPUE (Figure 3.2-12) was lowest in the Port Colborne area, higher in the vicinity of Long Point, very high in Inner Bay and highest in the Nanticoke area. The recreational fishery near Port Colborne had uniformly low CPUEs, with an increase in 2002 to 2004. The data from Port Colborne is echoed in the assessment data from New York (NYDEC 2004). Directed yellow perch CPUE was substantially higher for the years 2001-2003, than it was in the 1990s. The NYDEC gillnet index showed an increase in yellow perch abundance over the years 1999-2004, with 2002 and 2004 showing a much higher abundance.

A total of 118,408 yellow perch were caught and 86,783 harvested during the 2003 summer recreational fishery in Ontario (June-August) (Arnold 2004a). Almost all of these fish were harvested from the western half of the rehabilitation zone. There was 0.9% harvested from Port Colborne and Port Maitland. The 2004 winter fishery in Long Point Bay resulted in a total catch of 535,399 yellow perch of which 236,051 were harvested.

Long Point Bay is an extremely important spawning area due to its large area of favourable habitat for incubation and for juveniles. Long Point Bay origin fish tended to remain close to the bay (MacGregor and Witzel 1987). Thus, the concentration of fish southeast of the Grand River is hypothesized to be supported by the limited spawning and juvenile habitat in that area. Recovery of suitable habitat in the lake effect zone of the Grand River could be very significant in increasing the supply of yellow perch in this area of the lake.

The Yellow Perch Task Group produced this estimate for consistency with previous years, but recognized that some assumptions of the analytical approach may be violated because of the stock structure. A population model of the Long Point Bay area stock was developed by Belore and Witzel (unpubl.data) and indicated that yellow perch abundance fluctuated between 563,000 fish and 4.7 million fish (figure 3.2-13)(Table 3.2-2). This model may underestimate the total number of fish present, because it does not include the fish harvested from the recreational fishery. During 2003-2004, the recreational summer fishery harvested 62,073 perch in this area, and the winter fishery (2004) harvested 236,051 yellow perch. In terms of weight, the commercial fishery in Long Point Bay harvested 99,399 lbs and the recreational fishery harvested an estimated 52,503 lbs.

Yellow Perch Status Indicators

Table 3.2-3 compares historic and current yellow perch status indicators from surveys (Long Point Bay gillnet, trawl and Partnership gillnet surveys), commercial and catch-age analysis sources. Average indicators for the 1980s, 1990s and during the rehabilitation period (2000-2004) are presented.

Average abundance indices of yellow perch ages 2 and older were based on population estimates for Ontario statistical district 4 (OE 4 1994-2003 Belore and Witzel, unpubl.), Long Point Bay index gillnetting (1986-2004) and eastern basin Partnership gillnet surveys (1989-2004). The OE 4 catch-age analysis model used commercial gillnet harvest and Long Point Bay index gillnet survey data. The Long Point gillnet index illustrated the decline of yellow perch abundance from the 1980s (1,360 perch/km) to the 1990s (132 perch/km) and the subsequent recovery since 2000 (579 perch/km) (table3.2-1). Catch-age analysis also described the rebound in yellow perch abundance from the 1990s (0.8 million yellow perch) to the current decade (3.7 million). The Partnership survey trends within the eastern rehabilitation zone conformed to this pattern with abundance dropping from 179 perch/km of gill net (1989) to 49 perch/km (1990s mean), followed by recovery (356 perch/km 2000-2004 mean). While recovery was apparent throughout the eastern basin, the greatest improvement was adjacent to Long Point Bay (west of the Niagara cap area) where perch densities were several times that observed in the Niagara cap area (Figure 3.2-11).

Total mortality (Z) estimates from catch-age analyses were lower for the recent period (2000-2003 mean=0.46) compared to the 1990s (mean=0.92). Similarly, survival was high from 2000-2003 (63%) compared to the 1990s (40%). Estimates of exploitation were much lower since 2000 (mean=2%) compared to the previous decade average (18%).

Mortality estimates based on survey data were derived for cohorts by linear regression with catch curves ($\log_e$(catch)) for ages 3 to 6. In addition, survival was estimated using the Chapman-Robson minimum variance unbiased approach (Everhart *et al.* 1975). Since the Chapman-Robson method is applied to age frequencies, catch rates (perch/gang) were multiplied by 100 to perform the calculations. Table 3.2-3 provides ranges of mean total mortality (Z) estimates for the 1980s, 1990s and 2000s time periods from the Long Point Bay gillnet survey and for the 1990s and 2000s from the Partnership survey. The ranges represent average mortalities derived using catch curve and the Chapman-Robson method. Time periods represented by cohorts were designated based on the temporal proximity of age 4 yellow perch. Survival rates from survey data were a function of Z. Independent survey estimates of total mortality were higher than those derived from catch-age analysis. Long Point Bay survey average total mortality estimates for three time periods ranged from 0.86-1.15 (1986-1989), 1.17-1.18 (1990-1999), 0.59-0.81 (2000-2004). Partnership mortality estimates were comparable for the 1990s (1.20-1.33) and the 2000-2004 period (0.48-0.76). Estimated survival was highest in the recent 2000-2004 period based on data from the Long Point Bay (45-56%) and Partnership (47-63%) surveys compared to previous decades.

Spawning stock size was represented by ages 3 and older since mean age at 50% maturity (female - spring) ranged from 2.9-2.5 based on logistic regression of Partnership maturity data collected during the 1990s and 2000s. Assuming recruitment to fisheries occurs at age 2, stock to recruit ratios were derived with a two year lag between spawning and recruitment. Average stock recruitment ratios were higher since 2000 compared to the 1990s based on catch-age analysis, the Long Point Bay and Partnership gillnet index. Based on the Long Point survey, the ratio was very high during the 1980s (19) compared to the 1990s (3) and 2000s (10). In contrast, young-of-the-year trawl indices from Inner Long Point Bay have declined: 80s mean=493; 90s mean=211; 2000s mean=122 YOY per trawl hour. Reduced recruitment at higher stock sizes is consistent with a Ricker type stock-recruit relationship, although factors other than stock size are known to influence recruitment significantly. Data shows that age 2 recruitment has been higher since 2000, owing largely to the strength of the 1998 year class, and the relatively strong 2001 year class.

Natural mortality was assigned a value of 0.4 following analyses and extensive literature reviews by Dietz *et al.* (1997).

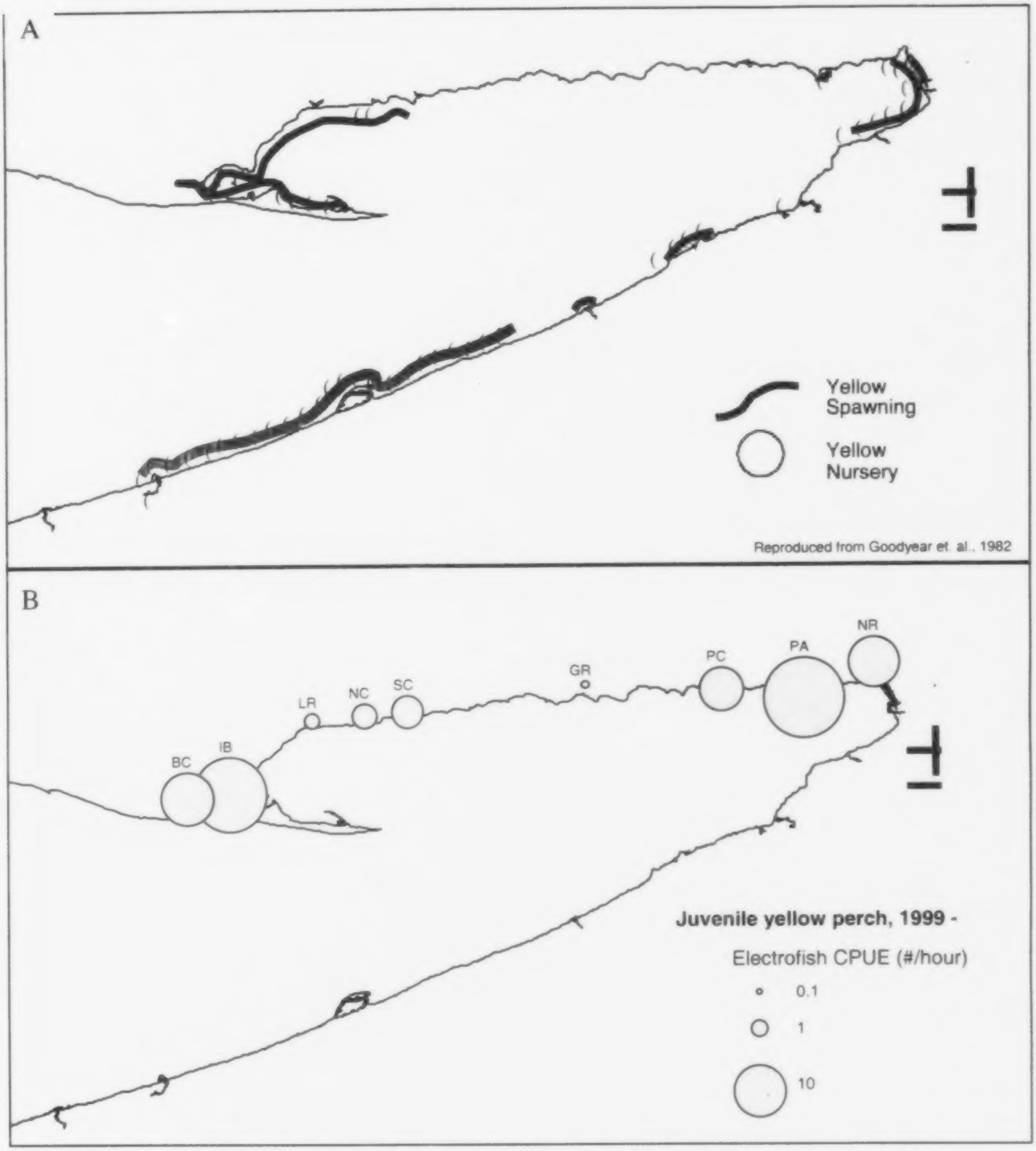
Yellow perch exhibited stable or increasing size at age from 1989 to the present despite an apparent increase in survival and abundance. The diet of yellow perch appears to have adapted to the colonization of round gobies as these prey were frequently found in stomachs of yellow perch collected from Long Point Bay (L. Witzel unpubl. data).

The mean age of yellow perch harvested commercially appeared to be slightly higher (4.2) since 2000 compared to the 1990s (3.9) in samples collected from statistical district 4 (OE-4). These averages for each period (1990-1999) and (2000-2004) were derived from the annual mean age in the harvest.

The population age structure from the Long Point Bay gillnet survey also appeared older since 2000 (mean age=3.3) compared to the previous two decades (means=3.0). The Partnership index conformed to this general pattern within the east basin rehabilitation area with population mean ages of 3.0, 2.6 and 3.2 for 1989, the 1990s and 2000-2004 respectively.

The maturation schedule of yellow perch appeared stable or possibly exhibited an acceleration of onset of sexual maturity between the past and current decade (from 2.7 to 2.6 male, 2.9 to 2.5 female)(figure 3.2-14). Improved growth is consistent with earlier onset of maturity. Compared to the mean age of yellow perch harvested, the age at 50% maturity produced Abrosov values of 1.0 (1990s) and 1.7 (2000-2004). The significance of the recent higher Abrosov value is poorly understood given highly variable recruitment, the strong influence of environmental conditions on recruitment and changing food web. In the past, strong recruitment events have coincided with younger perch population structure, under conditions that were potentially more favourable than present.

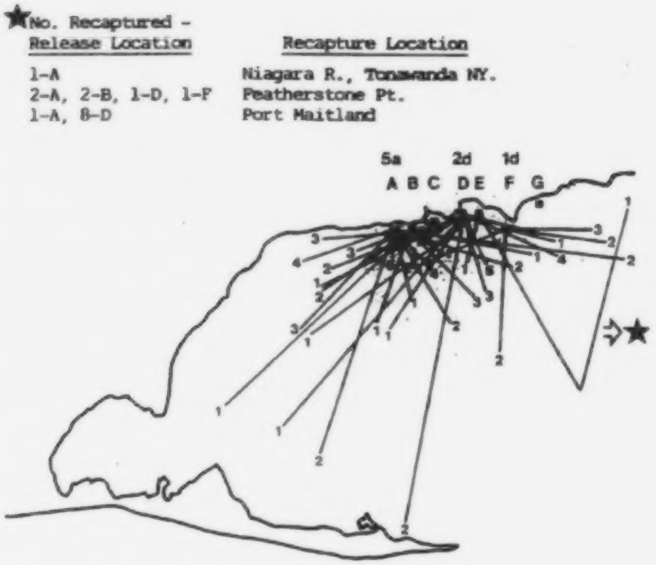
Within the Lake Erie Committee's management unit 4 (MU 4), Ontario's commercial harvest from 1984-1989 averaged 521,000 lbs. Harvest declined during the 1990s, averaging 89,000 lbs. During this decade, mortality was equal to or greater than the 1980s, while recruitment was considerably lower. Since 2000, the status of east basin yellow perch has improved in terms of survival, growth and abundance, with the most significant contributions from the 1998 and to a lesser extent, the 2001 year classes. From 2000-2004, Ontario's commercial harvest in MU 4 averaged 69,000 lbs. In the future, increased fishing rates would reduce survival from levels observed during the rehabilitation period (2000-2004). It is conceivable that reduced survival might be compensated for by increased recruitment, given that lower stock sizes seemed to produce stronger year classes historically. There is no guarantee of this however, due to many other biotic and abiotic influences on year class strength. Long Point Bay (trawl and gill net), and Partnership surveys support an allocation process of forecasting recruitment, describing abundance and survival and illustrating the spatial distribution of yellow perch in eastern Lake Erie.



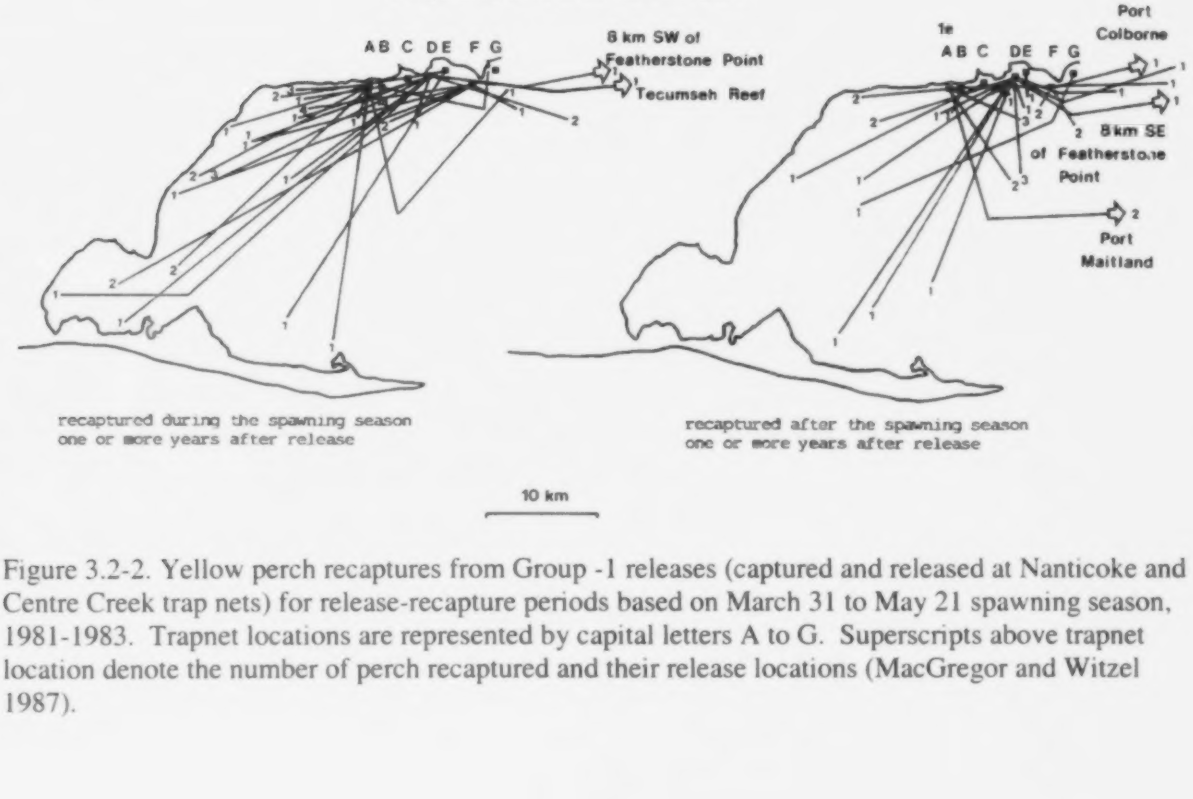
A
Yellow Spawning
Yellow Nursery
B
BC
IB
LR
NC
SC
GR
PC
PA
NR
Juvenile yellow perch, 1999 -
Electrofish CPUE (#/hour)
0.1
1
10

Reproduced from Goodyear et. al., 1982

Figure 3.2-1. The eastern basin of Lake Erie showing A) documented yellow perch spawning and nursery areas (Goodyear et al. 1982) and B) relative concentrations of juvenile yellow perch as standardized catch from nearshore and lower tributary electrofishing surveys conducted by MNR, 1999-2002. Site codes are as follows: BC-Big Creek, IB-Inner Long Point Bay, LR-Lynn River and Black Ck, NC-Nanticoke Ck, SC-Sandusk Ck, GR-Grand River, PC-Port Colborne, PA-Point Abino, NR-Niagara River.


★No. Recaptured - Release Location
Recapture Location
1-A
Niagara R., Tonawanda NY.
2-A, 2-B, 1-D, 1-F
Featherstone Pt.
1-A, 8-D
Port Maitland
5a
2d
1d
A B C DE F G

released during and recaptured after the spawning season in the same year


A B C DE F G
8 km SW of Featherstone Point
Tecumseh Reef
1e
A B C DE F G
Port Colborne
8 km SE of Featherstone Point
Port Maitland
10 km

recaptured during the spawning season one or more years after release

recaptured after the spawning season one or more years after release

Figure 3.2-2. Yellow perch recaptures from Group -1 releases (captured and released at Nanticoke and Centre Creek trap nets) for release-recapture periods based on March 31 to May 21 spawning season, 1981-1983. Trapnet locations are represented by capital letters A to G. Superscripts above trapnet location denote the number of perch recaptured and their release locations (MacGregor and Witzel 1987).

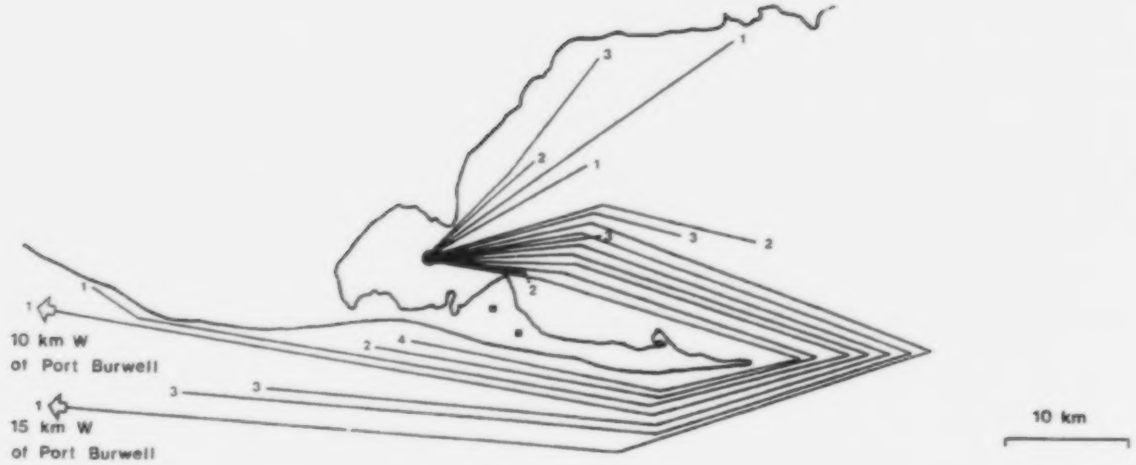

3
1
2
1
3
2
2
1
10 km W
of Port Burwell
2
4
3
3
1
15 km W
of Port Burwell
10 km

Figure 3.2-3. Yellow perch recaptures from Group-2 releases (captured and released in the Long Point Inner Bay area) for release-recapture periods based on March 31 to May 21 spawning season 1981-1983. Superscripts above trapnet location denote the number of perch recaptured and their release locations (MacGregor and Witzel 1987)

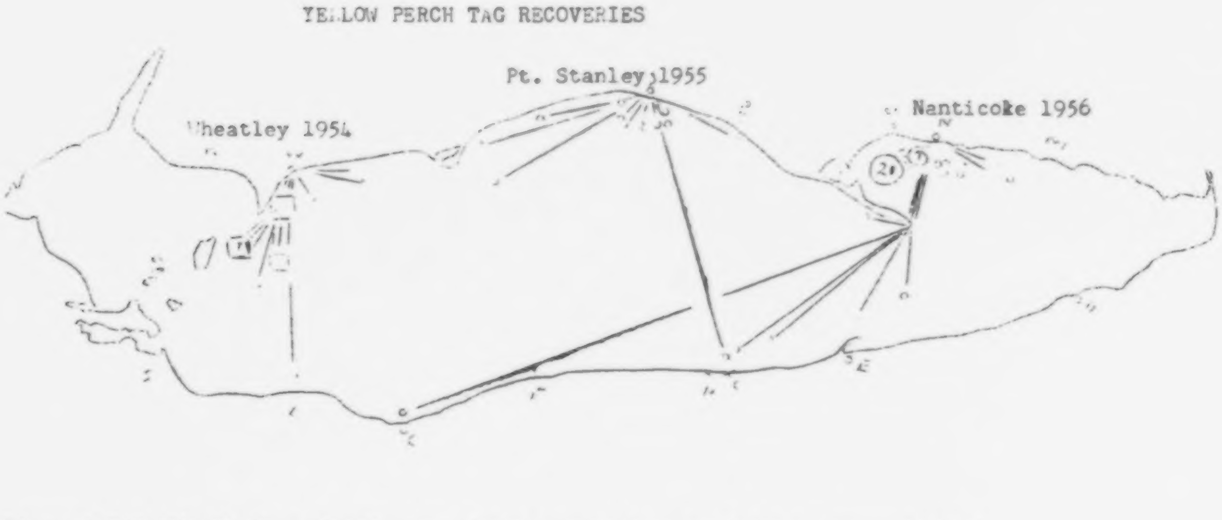

YELLOW PERCH TAG RECOVERIES
Pt. Stanley 1955
Wheatley 1954
Nanticoke 1956

Figure 3.2-4. Distribution of yellow perch tag returns from work by Ferguson (1958).

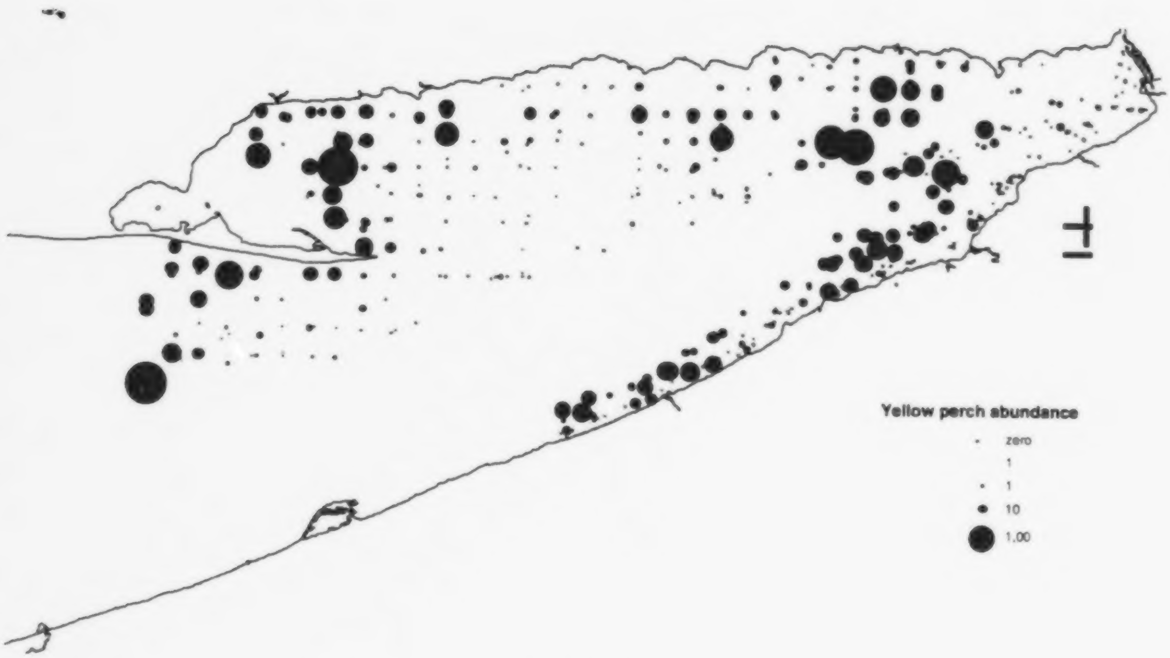


Figure 3.2-5. Location of Lake Erie, eastern basin gillnetting sites indicating catches of yellow perch. Sites within Canadian waters are randomly distributed and represent 301 sets of MNR-OCFA Partnership Index gillnets between 1998 and 2004. Sites within American waters are confined to areas where depths are <30 m and represent 239 sets of NYSDEC warm-water index gillnets between 1998 and 2003. The relative size of each catch (#/set) is represented by the relative size of each circle as indicated.

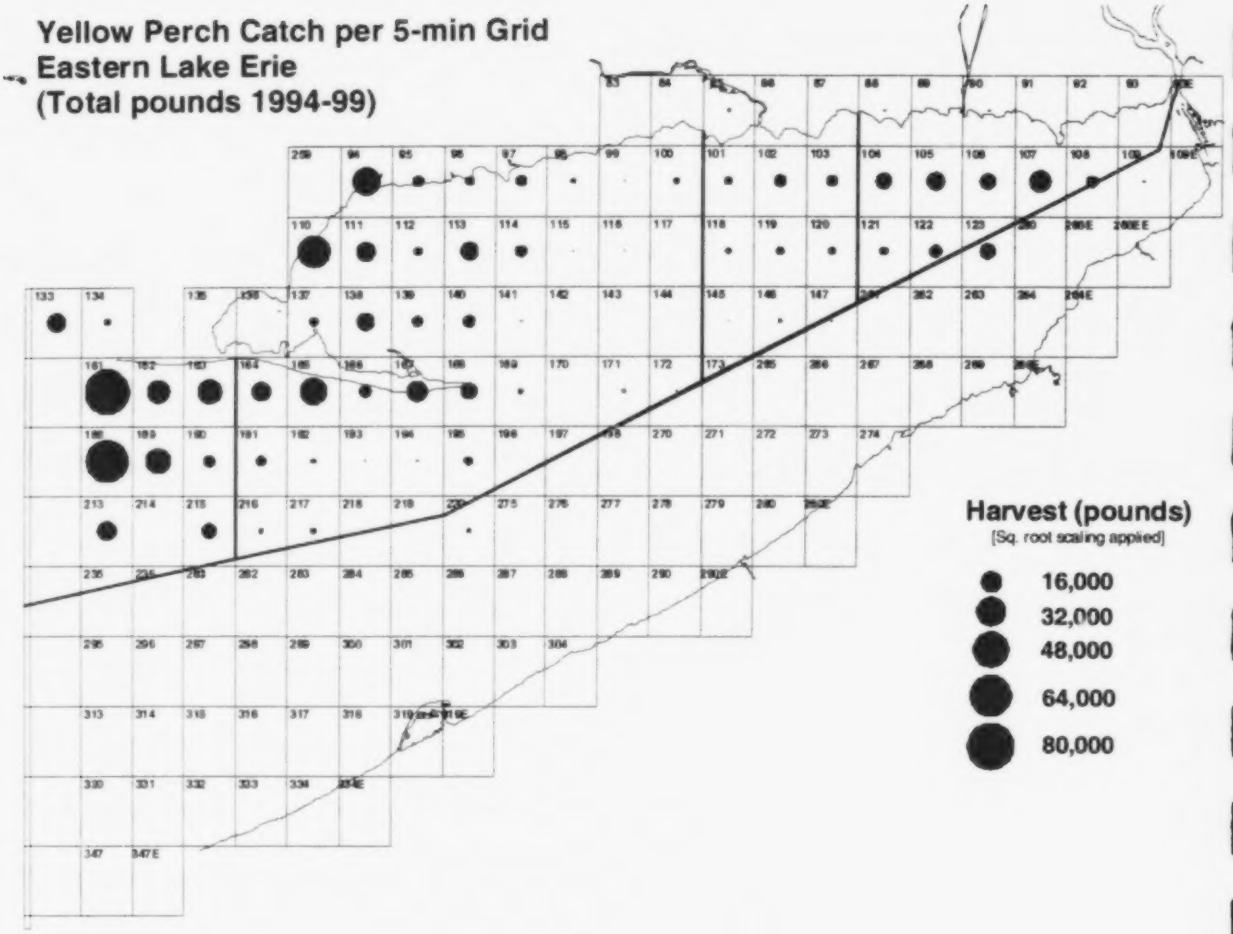

Yellow Perch Catch per 5-min Grid
Eastern Lake Erie
(Total pounds 1994-99)
Harvest (pounds)
[Sq. root scaling applied]
● 16,000
● 32,000
● 48,000
● 64,000
● 80,000
83 84 85 86 87 88 89 90 91 92 93 93E
94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 109E
110 111 112 113 114 115 116 117 118 119 120 121 122 123 260 260E 260EE
133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 261 262 263 264 264E
161 162 163 164 165 166 167 168 169 170 171 172 173 265 266 267 268 269 269E
188 189 190 191 192 193 194 195 196 197 198 270 271 272 273 274
213 214 215 216 217 218 219 220 275 276 277 278 279 280 280E
235 236 282 283 284 285 286 287 288 289 290 290E
295 296 297 298 299 300 301 302 303 304
313 314 315 316 317 318 319
330 331 332 333 334 334E
347 347E

Figure 3.2-6. Commercial harvest of yellow perch by grid for years 1994-99.

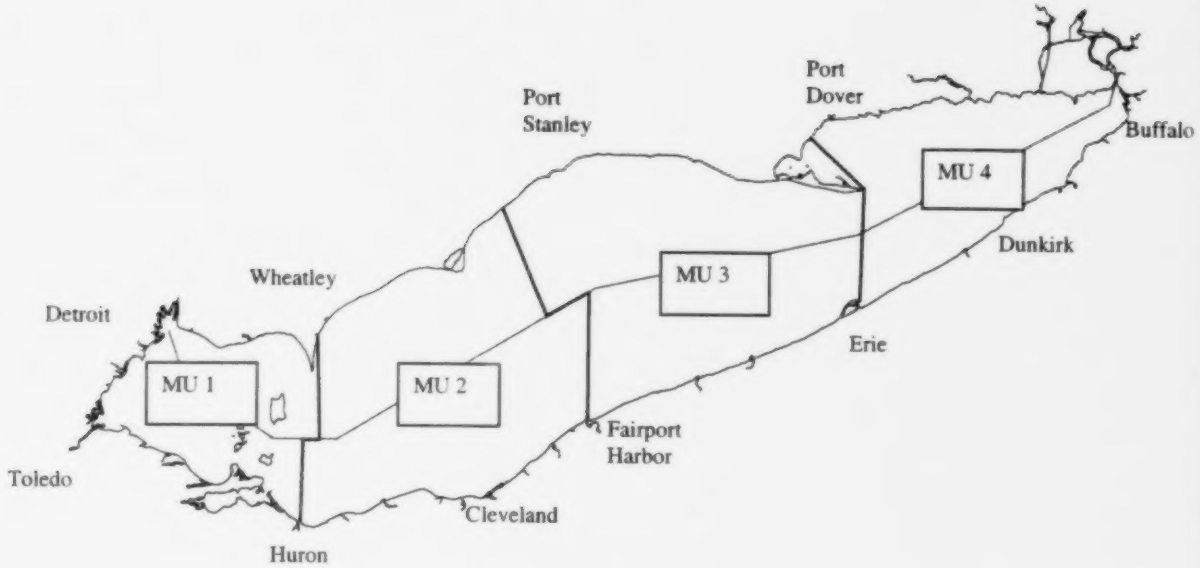

Port Stanley
Port Dover
Buffalo
MU 4
Dunkirk
MU 3
Wheatley
Detroit
Erie
MU 1
MU 2
Fairport Harbor
Toledo
Cleveland
Huron

Figure 3.2-7. Yellow Perch management units (MUs) of Lake Erie.

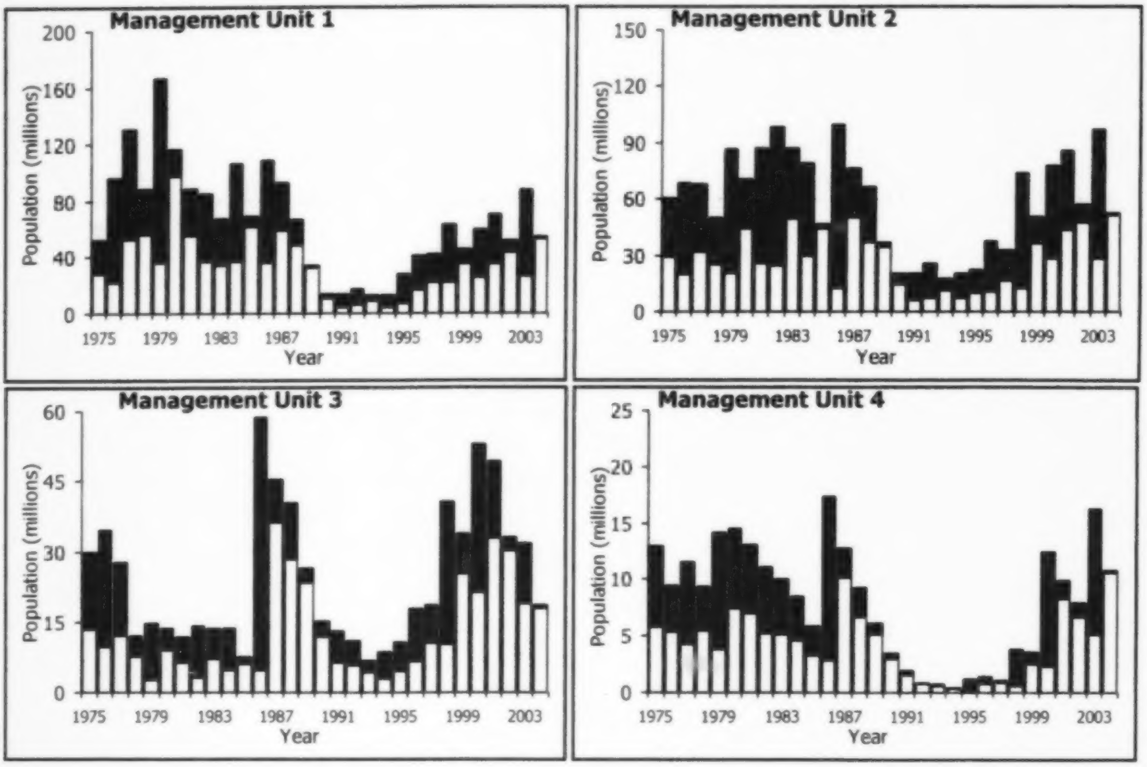
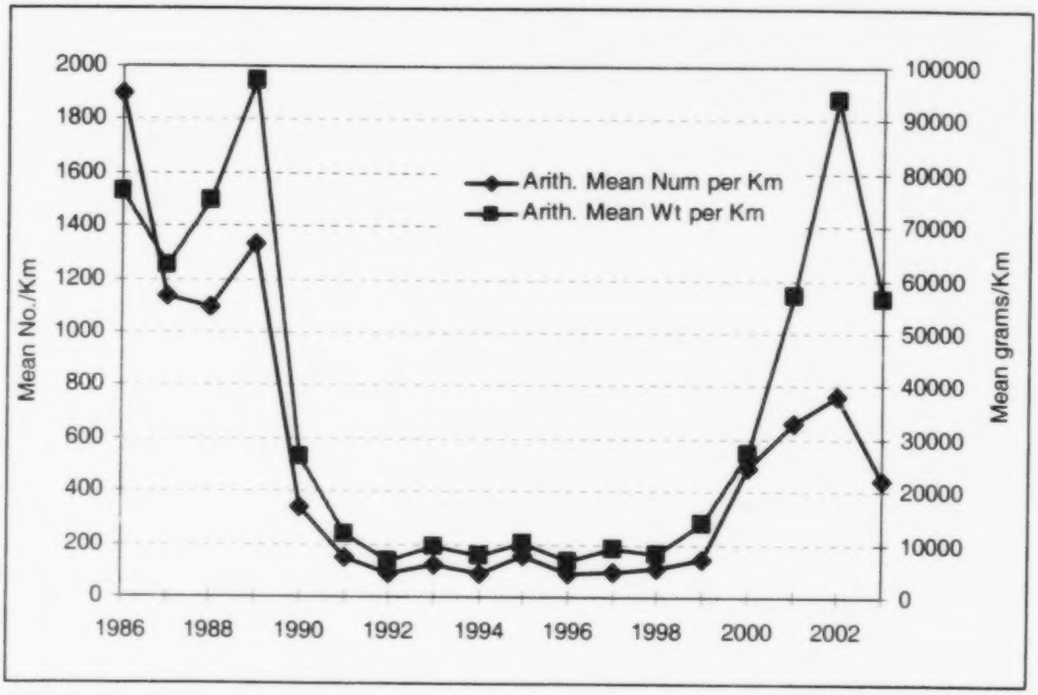


Figure 3.2-8. Lake Erie yellow perch population estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 2004 are from ADMB CSI Catch-Age and parametric regressions for age 2 (Cook *et al.* 2004).



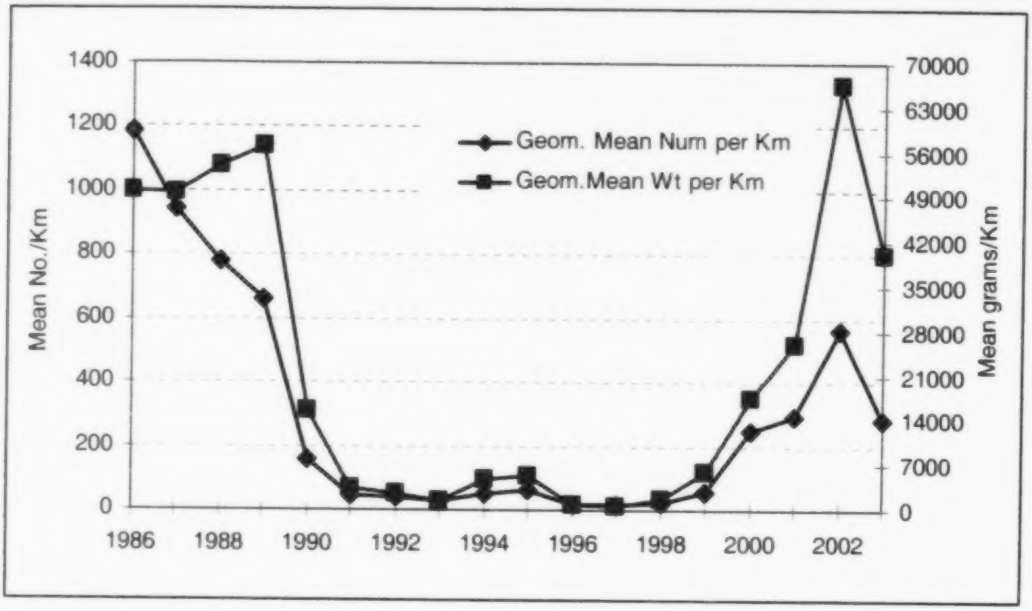


Figure 3.2-9. Trends in abundance and biomass of yellow perch observed in the nearshore waters of Long Point Bay, between 1986 and 2003. Data are shown as arithmetic (upper chart) and geometric (lower chart) mean number (left Y-axis) and weight (right Y-axis) per kilometre of net set overnight.

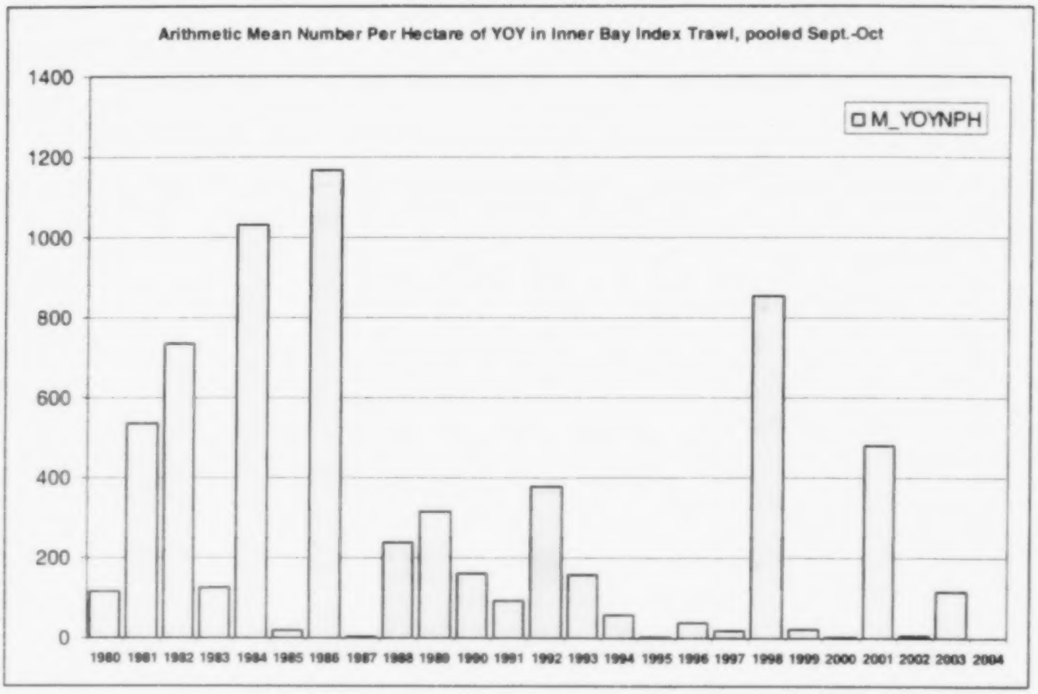


Figure 3.2-10. Trend in abundance of age 0 yellow perch in Inner Bay (year class strength), interpreted to indicate year to year variation in success of perch reproduction.

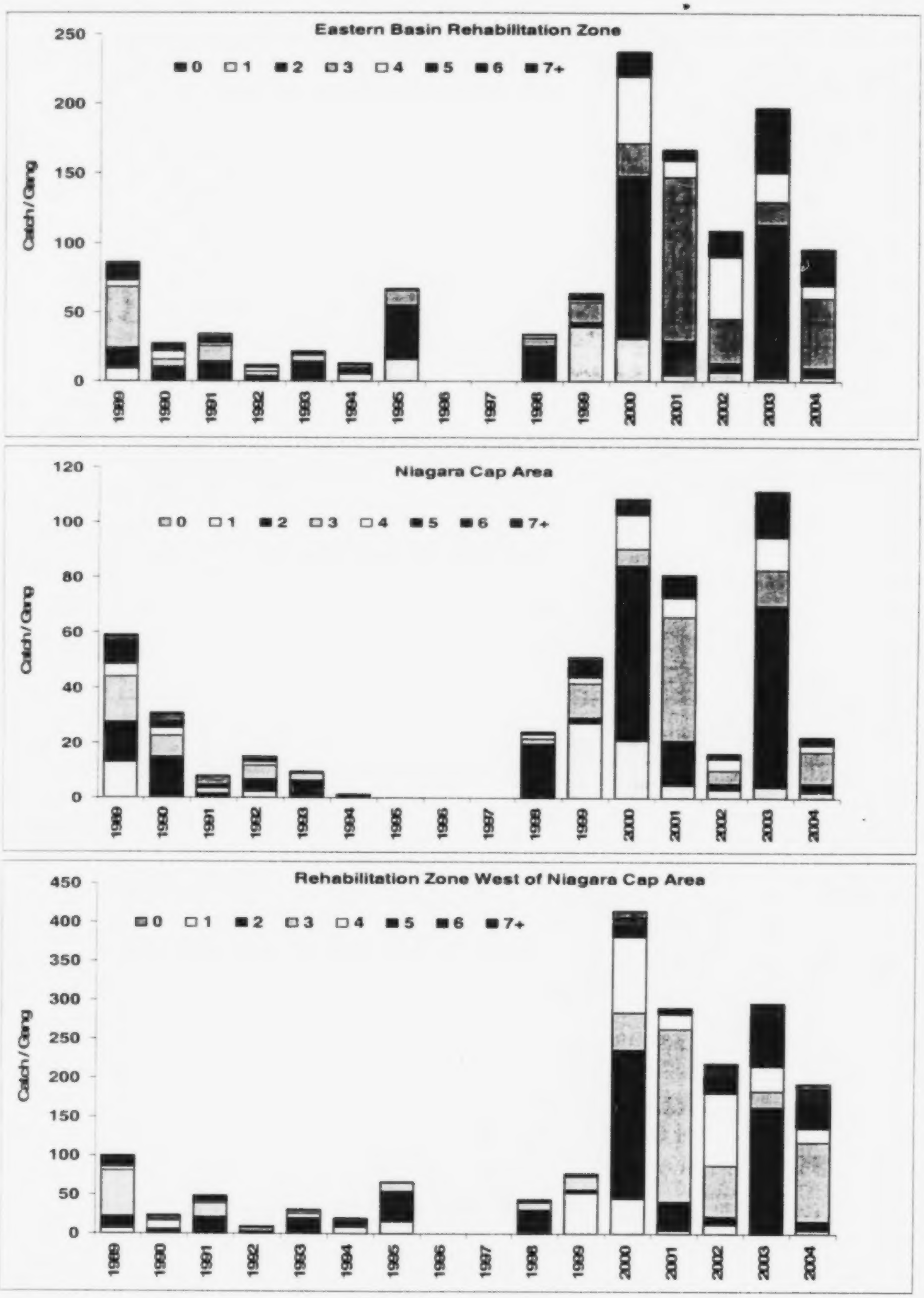
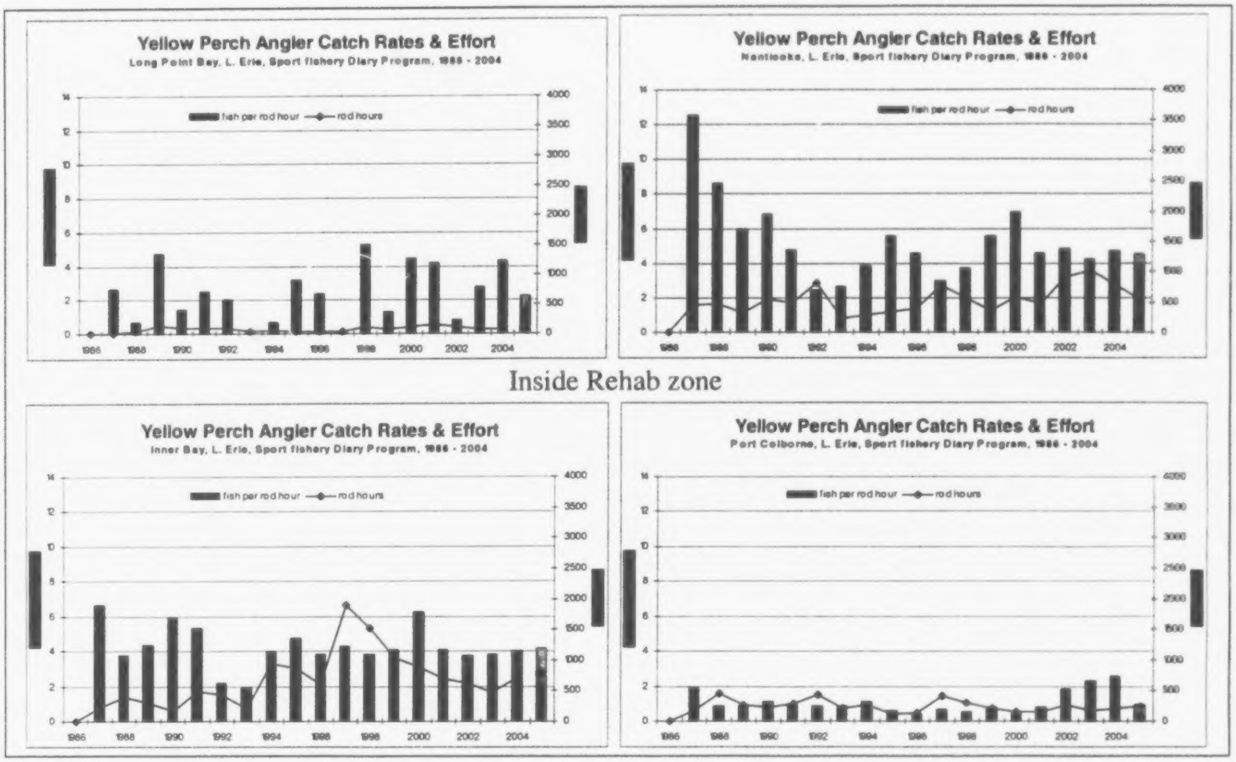


Figure 3.2-11. Yellow perch catch per effort by age class and total for the eastern rehabilitation zone from partnership index fishing. Upper figure represents entire zone, middle figure represents Niagara Cap Area, and bottom figure represents remainder of zone to west. Study was not completed in 1996 and 1997. Low sample size in 1995. Ages 7 and older pooled.



Inside Rehab zone

Rest of Lake outside rehab zone

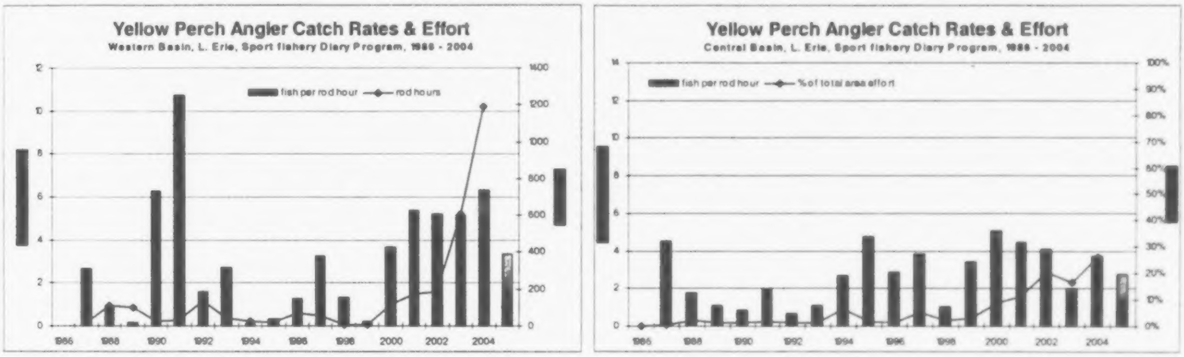


Figure 3.2-12. Observation of angler CPUE and sample effort from angler diary participants targeting yellow perch, by area (1986-2004). Last column in graphs denote average for 1990-2003.

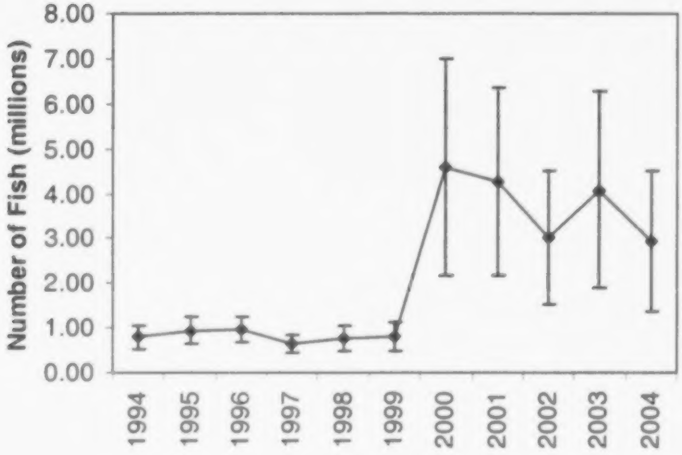


Figure 3.2-13. Estimated number of age 2 and older yellow perch in the Long Point Bay area from catch at age analysis. Error bars represent ± 2 SD. (Belore and Witzel unpubl.)

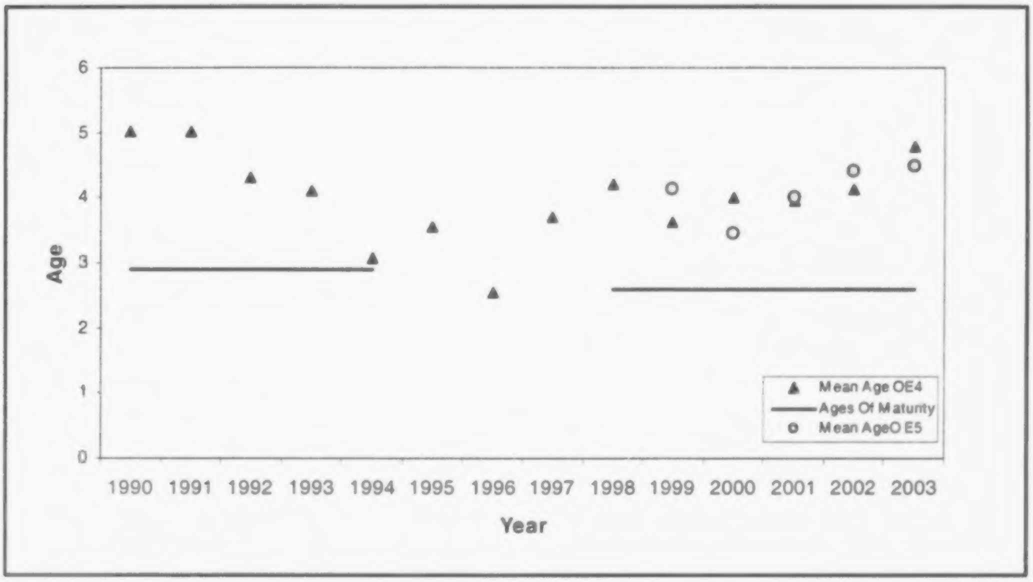


Figure 3.2-14. A comparison of mean age of yellow perch in the fishery to mean age of maturity (2.9 for 1990-94, 2.6 for 1998 to 2003) for OE 4 (Long Point vicinity) and OE5 (Haldimand - Niagara) as available.

Table 3.2-1. Reported yellow perch targeted effort and harvest in pounds, and estimated harvest in numbers of fish from the Long Point Bay area (Belore and Witzel unpubl.data)

Year	Harvest (lbs)	Harvest (number)	Effort (kms)
1994	46,515	189,178	1,294
1995	36,061	128,721	1,598
1996	38,248	145,841	1,243
1997	32,931	131,206	932
1998	26,953	90,550	617
1999	38,624	130,507	430
2000	19,630	63,569	178
2001	20,920	61,248	88
2002	33,109	88,458	49
2003	22,416	52,673	78
2004	22,645	56,481	82

Table 3.2-2. Estimated abundance of age 2 and older yellow perch (in number of fish) in the Long Point Bay area (Belore and Witzel unpubl. data).

Year	2	3	4	5	6+	Total
1994	366,405	274,640	62,795	41,259	38,846	783,944
1995	545,195	241,495	110,206	13,305	16,972	927,173
1996	482,967	359,205	95,849	22,783	6,259	967,063
1997	152,655	318,379	144,943	20,564	6,231	642,771
1998	449,020	101,347	159,262	50,369	9,311	769,309
1999	363,092	299,094	56,081	69,418	26,013	813,698
2000	4,129,710	241,587	160,003	22,658	38,556	4,592,513
2001	1,236,320	2,761,510	150,422	90,883	34,769	4,273,904
2002	224,775	827,834	1,791,030	93,634	78,216	3,015,489
2003	2,075,780	150,638	551,263	1,182,910	113,500	4,074,091
2004	246,730	1,390,710	99,382	356,556	838,514	2,931,892

Table 3.2-3. Yellow perch indicators based on surveys, and fishery data collected, 1980s to 2004

Indicator	**1980's**	**1990's**	**2000's**	**Comments / Possible Causes**
Abundance CATCH-AGE ANALYSIS LPB		0.8 million	3.7 million	
Abundance - CPE LPB INDEX 2+ (#/km)	1,360	132	595	
Abundance - CPE PARTNERSHIP INDEX 2+ (#/km) REHAB ZONE	180	50	391	
Exploitation % COMMERCIAL CATCH-AGE ANALYSIS 2+		18	2	Obs catch/population 2+, doesn't include sport fishery
Total Mortality Z CATCH-AGE ANALYSIS 3+		0.916	0.462	
Total Mortality Z LPB INDEX 3-6	0.86-1.15	1.17-1.18	0.54-0.80	time period for year class based on age 4
Total Mortality Z PARTNERSHIP INDEX 3-6		0.98 -1.20	0.43 - 0.77	time period for year class based on age 4
% Survival CATCH-AGE ANALYSIS 3+		40	63	
% Survival LPB INDEX 3-6	33-43	32-33	45-59	time period for year class based on age 4
% Survival PARTNERSHIP INDEX 3-6		34-48	47-65	time period for year class based on age 4
Stock 3+ : Recruitment Ratio (age 2) CATCH-AGE ANALYSIS		1	2	
Stock 3+ : Recruitment Ratio (age 2) LPB INDEX	19	3	3	
Stock 3+: Recruitment Ratio (age 2) PARTNERSHIP REHAB ZONE		2	8	
Recruitment CATCH-AGE ANALYSIS (age 2)		0.4 million	1.7 million	
Recruitment YOY LPB INDEX (#/ha)	429	178	121	
Recruitment LPB INDEX (age 2) (#/km)	501	38	171	
Recruitment PARTNERSHIP REHAB ZONE (age 2) (#/km)		34	152	
Natural Mortality	0.4	0.4	0.4	Dietz et al. 1997
Growth PARTNERSHIP AGES 1 - 4		stable or improving		altered forage base ie: round gobies, mayflies
Mean Age in Harvest OE 4		3.9	4.2	
Mean Age in Population LPB INDEX	3.0	3.0	3.2	
Mean Age in Population PARTNERSHIP INDEX	3.0	2.6	3.1	
Age at 50% Maturity Male PARTNERSHIP INDEX REHAB ZONE		2.7	2.8	
Age at 50% Maturity Female PARTNERSHIP INDEX REHAB ZONE		2.9	2.6	
Abrosov Index (female)		1.0	1.6	
Yield (lbs) Ont. Statistical Districts OE 4 & OE 5	666,020	233,655	122,484	

Note: Total mortality and survival estimates from gillnet surveys are means for year classes 1982-1985; 1986-1995; 1996-1998 for the 3 periods

Total mortality estimates from survey data are presented as a range using catch curve analysis and Chapman Robson approach (Everhart et al. 1975)

3.3 Smallmouth Bass[4]

In eastern Lake Erie, smallmouth bass stocks are well established in the coastal regions from Long Point to Fort Erie on the Ontario side and throughout the coastal waters of Pennsylvania and New York, including the Niagara River. Stock structure has not been investigated to date, but in Ontario there appears to be at least two. One is centered in the Long Point Bay area, and the other is near Port Colborne. The inner bay of Long Point Bay is well documented as the primary spawning area for the Long Point Bay stock (Whillans 1977, Goff 1984, Pynenburg and Witzel 1985, MacGregor and Witzel 1987).

Smallmouth bass favour rocky shoals made of cobble and gravel in moderate to shallow depths (Hubbs and Bailey 1938, Coble 1975, Edwards *et al.* 1983), found in the nearshore waters of eastern Lake Erie. Goodyear *et al.* (1982) identified the nearshore waters from west of Port Maitland to Fort Erie as a major spawning area, but the instability of water temperatures in the western half of this region may prevent significant reproductive success. Tributaries along the north shore of eastern Lake Erie do not support any known spawning areas for lake-based smallmouth bass populations. Conversely, along the south side of the basin, several tributaries provide spawning and nursery areas for bass in addition to lake spawning habitat (Goodyear *et al.* 1982). Tributaries warm more quickly than the lake during the spring, and consequently, tributary spawning bass of lake origin initiate spawning much earlier than do lake spawners.

New York State instituted a spring fishery for smallmouth bass beginning in 1994 (Einhouse *et al.* 2002). This fishery commences the first Saturday in May and continues until the third Saturday in June, when the bass fishing season opens statewide. A one-fish harvest limit with a 15-inch size minimum is in effect for the early season. The early season fishery is rationalized as being an acceptable management practice on the grounds that bass do not begin nesting in the lake until mid to late June, and therefore were not fully protected by the existing statewide season (Einhouse *et al.* 2002). In the New York waters of Lake Erie, most smallmouth bass spawning is thought to occur in depths greater than 4 m, where anglers could not visually target nesting bass. The typical early season bass angler was a specialist fisher, whose primary interest was in catching and not keeping bass. Enforcement of this fishery was not considered difficult as the lake areas targeted by these bass specialists were clearly distinct from the river mouths and areas where tributary spawning bass were vulnerable.

The bass season in Ontario waters of Lake Erie begins on the last Saturday of June and ends November 30. A proposal in 1997 to open the bass fishing season earlier was rejected by stakeholders. In addition to a closed season, Ontario continues to enforce no-fishing sanctuaries in several key bass spawning areas of eastern Lake Erie, such as in Inner Bay(figure 3.3-1), and nearshore areas in the vicinity of Port Colborne, and east of Windmill Point, near Fort Erie (Table 1.3-1). Smallmouth bass are a major predator of the nearshore fish community during the summer months when they are active and feeding. The results of a study from 1988 (MacGregor and Howe 1989) involving on-board observation and simulated commercial fishing practices in areas of Long Point Bay led to additional restrictions being imposed on commercial gill netters to reduce mortality of bass (see Section 1.3).

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[4] Detailed information is provided for smallmount bass because bass do not receive the same frequency or degree of status review as other important Lake Erie Fish species.

In addition to sanctuaries, Ontario has restricted commercial fishing in selected nearshore areas along the north shore to protect bass and minimize conflicts between recreational and commercial fishermen (Section 1.0). Commercial fishing is prohibited year round or for critical times of the year in most of the nearshore waters of Long Point Bay and a large coastal zone east of the Grand River from about Mohawk Point to Fort Erie (Figure 1.3-2 and 1.3-3).

Thermal Ecology Adaptations – The Long Point Bay Model

Short term fluctuations and seasonal cycles of water temperatures play a key role in the ecology and life history adaptations of smallmouth bass populations to regions within eastern Lake Erie. A good example of this adaptation is the bass population of Long Point Bay. Tagging studies have shown that yellow perch, rock bass and smallmouth bass migrate during early spring from Outer Bay and possibly areas further east to spawn in Inner Bay (Kelso 1973, MacLean and Teleki 1977, MacGregor and Witzel 1987). Some marked bass recovered in Inner Bay travelled distances exceeding 30 km (Figure 3.3-2). Diving surveys indicate that most of the spawning by smallmouth bass occurs in Inner Bay (Goff 1984, Pynenburg and Witzel 1985). However, the coarse granular substrates preferred by smallmouth bass do not exist in Inner Bay (Smith 1979, Heathcote 1981) but instead spawning occurs on sand or silty-sand (Witzel 1989). The principal cover available in this area is submerged macrophytes, predominately stonewort (*Chara* spp.) and wild celery (*Vallisneria americana*) (Witzel 1989, Knapton and Petrie 1999).

Little spawning occurs in Outer Bay despite the apparent abundance of suitable substrate (Heathcote 1981, Witzel 1989). This may be indicative of temperature influences. Water temperatures in Inner Bay warm more quickly in the spring, reach a higher maximum during summer, and cool more rapidly in the fall than they do in Outer Bay (Leach 1981). Water temperatures approaching 15° C are required for initiation of spawning and the nearshore waters of Outer Bay do not warm to 15° C until about mid to late June, a full month or more later than Inner Bay. Figure 3.3-3 shows temperature data collected in 1995, which is generally representative of temperature trends in the area. During the late spring and early summer period, rapid temperature drops in the nearshore waters caused by wind-induced events are not uncommon. These events can impact relatively small or large coastal regions anywhere in Outer Bay and across much of the north shore east of Long Point Bay to Port Colborne (Dunstall *et al.* 1990). Cold-water incursion events can take place in the East Basin during May to August and can disrupt bass spawning and nesting activities resulting in partial or total loss of eggs/fry. Protected embayments like Inner Bay and the far eastern end of Lake Erie are less susceptible to cold-water events and the potential negative effects on bass reproduction.

The majority of bass spawning/nest guarding activities in Inner Bay will have been completed by the opening of bass fishing season during most years. However, during cool years or years when nesting activities have been disrupted, a second spawning cycle by smaller fish may extend the reproductive period past the opening day of the fishery. Adult bass leave Inner Bay soon after they complete spawning/nesting activities and return to the deeper cooler waters of Outer Bay where they establish summer home ranges near rocky shoals.

Shuter *et al.* (1980) reported two critical stages in the first year of life during which young bass are vulnerable to temperature effects. The first period was from fertilization until bass fry dispersed from the nest. Exposure of the brood to extreme temperatures during this stage resulted in high mortality. The second critical period was the first winter when young bass die due to starvation. Size of bass fry was important in determining over-winter survival because age 0 bass do not feed at temperatures below 10° C and must rely on energy reserves acquired during the first growing season to carry them through the winter starvation period. Of the two embayments of Long Point Bay, Inner Bay provides the better thermal habitat for successful reproduction and survival of young. Rapid warming and relatively stable water temperatures of Inner Bay permit earlier spawning and longer growth period for age 0 bass to maximize body size and increase their chances of over-winter survival. Age 0 bass remain in nursery areas of Inner Bay through the summer and at some time during the fall, move to Outer Bay.

Lake warming in the east basin lags behind the central and west basins (Schertzer *et al.* 1987). During late winter/early spring, floe ice accumulates in the east basin and will form a barrier above the ice boom at the mouth of the Niagara River. Water temperatures above the ice boom (e.g. at Buffalo N.Y.) remain near 0° C while surface waters in adjacent areas have warmed to above 5° C (Figure 3.3-4). Water temperatures do not reach the 15° C threshold necessary for bass spawning until about the second week of June. Bass spawning areas near Port Colborne and west of Fort Erie have a similar warming rate (Figure 3.3-4). Savoie *et al.* (1982) reported peak bass spawning activity between June 14 and 22 during 1980 and 1981 surveys. Brunet *et al.* (1987) observed peak spawning between May 26 and June 14 at Waverly beach, Windmill Point, Point Abino and Thunder Bay. Smallmouth bass populations at the far-eastern end of the basin spawn later than the Long Point Bay populations or lake-tributary spawners in New York and Pennsylvania. This area of the basin generally has steadily increasing temperatures that do not rapidly fluctuate during the spawning/nesting period (Figure 3.3-4), unlike the thermally unstable coastal environment west of Port Colborne where little, if any, smallmouth bass spawning has been observed.

The quantity and spatial distribution of smallmouth spawning on the New York side of eastern Lake Erie is not as well documented. Lake spawning in these waters is thought to occur in rocky areas of at a depth of 4 m or greater (Einhouse *et al.* 2002). The south shore is more protected from prevailing winds and it is possible that lake spawning by smallmouth bass occurs more widely across coastal waters of this region than on the northern side of the basin. Water temperatures on the south shore of eastern Lake Erie do not warm to the 15° C threshold until mid to late June (Figure 3.3-5). The south shore waters also have large fluctuations in water temperature, which may negatively effect bass reproduction. Tributary spawning bass may account for a larger component of recruitment to smallmouth bass populations in this part of the basin.

Trends in abundance

OMNR's Long Point Bay (Inner Bay) Fall Index trawl survey provides a reliable index of smallmouth bass recruitment at age 0. This survey, dating back to 1980, indicates age 0 bass recruitment has been higher in the time series after 1990 (Figure 3.3-6). Age 0 recruitment indices averaged about 7 bass/ha from 1980 to 1990 and 34.5 bass/ha from 1991 to present. The four strongest year classes during the 25-year time series have all occurred since 1993 (Figure 3.3-6). The most recent strong year class was in 2003.

Trend information describing the abundance of adult smallmouth bass in eastern Lake Erie is provided by three independent agency index gillnet surveys conducted annually in New York and Ontario waters[5]. Data show annual variations in smallmouth bass abundance exist across the east basin, however, year-to-year changes in abundance are not closely synchronized among survey areas (Figure 3.3-7). No obvious long-term trends in bass abundance are apparent, but some short-term patterns emerge within individual survey data series. The Long Point Bay bass population appears to have remained relatively stable across the entire time series of this survey (Figure 3.3-7), with peaks in 1990, 1995, 1997 and 2003. Low relative abundance occured in 1998 and 2004 (the lowest in the time series).

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[5] These surveys cover different years, months and areas of the east basin. Of these, the Ontario Partnership gill net survey has the broadest spatial coverage, encompassing all regions of the east basin on Ontario's side, but has the shortest time series. The survey began in 1989 and there was no sampling during 1996 and 1997. The Long Point Bay index gill net survey began 1986. Sampling is from June to August and sample sites include all nearshore areas (between 4 – 9 m bottom

A different picture of smallmouth bass abundance emerges from the recent survey years of New York's data series (Figure 3.3-7). Bass population size was near record high abundance in 2000 and then decreased during three successive years to 2003. This recent years downward trend ended with a small increase (27%) in relative abundance during 2004. The relative abundance of smallmouth bass in each year since 2000 has exceeded the average abundance observed during the pre-2000 period in New York's survey data. As smallmouth bass have different environmental conditions along the north shore compared to Long Point bay, and are known to spawn at different times, this variation is expected.

The Ontario Partnership survey also shows a decrease in bass abundance from 2000 (Figure 3.3-7), with abundance lower than the 1989-1995 period. This was evident in both the eastern and western halves of this basin-wide survey of Ontario waters (Figure 3.3-8), with the western half showing a significant decrease and the eastern half remaining more stable. The year 2000 peak in abundance of smallmouth bass, evident in New York's survey and the Ontario Partnership survey, but not the Long Point Bay survey, was attributed to recruitment of age 1 and 2 bass from the strong 1998 and 1999 year classes. The Long Point Bay (Inner Bay) index trawl survey indicates that the 1999 year class was the strongest observed during 25-years of trawl assessments (Figure 3.3-6). Surprisingly, this cohort was not readily apparent in the Long Point Bay index gillnet survey data during the 2000 or 2001 assessments. The 1999 year class did not contribute significantly to the total annual bass catch until 2002, when it comprised 48% of the catch. In 2003, as 4-year-olds, their contribution was 54% of the bass catch.

Total spatial coverage of the Ontario Partnership and New York gillnet surveys for the pooled sampling years from 1998 to 2004 is extensive, and encompasses a large portion of the smallmouth bass summer home range in eastern Lake Erie. Mapping of smallmouth bass catches (number/net) from this compilation shows a merged multi-year picture of relative abundance and distribution. Smallmouth bass were most often caught at 5 to 25 m depths of the basin (Figure 3.3-9). Bass likely exist in shallower depths as well, but would not be represented because index gillnets were not fished at bottom depths less than 5 m. Smallmouth bass densities appear to be greater along the south side of the basin (Figure 3.3-9) and the largest densities were observed in waters less than 20 m. The lake bottom along New York's coast has a steeper gradient than the Ontario side. Smallmouth bass on the New York side are concentrated in a band within the 5-25 m depth range. On the north side, bass appear to be more scattered, reflecting the irregular substrate and bathymetry of this region.

Recreational fishery surveys provide additional indicators of smallmouth bass abundance. In Long Point Bay, a roving angler survey has been conducted every summer since 1984 and covers the open waters of Inner Bay and the western portion of Outer Bay. Catch and harvest levels of smallmouth bass in this fishery have remained relatively stable with a peak in 1998 (Figure 3.3-10). In general, catch and harvest have tracked fishing effort directed at bass. Across the time series, catch per unit effort (CPUE) of smallmouth bass anglers have ranged between a low of 0.34 observed in 2001 and a

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depths) of Outer Bay. New York's warm-water gill net survey has the longest history of the three surveys. Annual assessments in this survey are now (since 1996) restricted to nearshore bottom sets (<12 m) during the month of September.

high of 0.72 in 1998 (Figure 3.3-10). Catch rates of bass anglers indicate that the availability of smallmouth bass increased during the mid-80's into the late 90's, and then decreased from 1998 to 2001. Most recent data indicate that smallmouth bass are at an average abundance (Figure 3.3-10).

In 2003, an estimated 94,171 smallmouth bass were caught during the period from June 2nd to August 31st (Arnold 2004a). Anglers kept only 26.4% (n=24,887 bass) of the total catch. Of the nineteen access points surveyed in 2003, 53.5% of the total bass catch and 43.6% of the total bass harvest came from anglers accessing the region's smallmouth bass fishery at Hoover's Marina on Nanticoke Creek, located west of the Nanticoke Thermal Generating Station (Arnold 2004a).

Lake wide Ontario recreational fishery data are collected through a volunteer angler diary program. Diary data reporting smallmouth bass catch paer unit effort and the amount of effort are shown for three Ontario regions of eastern Lake Erie – Long Point, Nanticoke, and Port Colborne as outlined in Figure 3.3-11. Long Point includes the open waters centered off the tip of Long Point. Angler diarists have caught an average 1.032 bass/rod-hr across all survey years. Catch rates generally have been lower during recent years (2000-2003 avg. CPUE=0.751), than earlier in the time series.

The Nanticoke diary reporting area encompasses the north shore region from Turkey Point to Tecumseh reef, east of Port Maitland. Angler diarists fishing in this area averaged 1.150 bass/rod-hr across all survey years (Figure 3.3-11). Highest catch rates were observed during 2000 when diarists experienced an outstanding 2.903 bass/rod-hr. Catch rates have remained high in recent years (2000-2003 Avg. CPUE=1.979 bass/rod-hr).

The Port Colborne diary reporting area encompasses the nearshore coastal waters east of the Nanticoke reporting area. Angler diarists in this region of the east basin have also experienced high catch rates for smallmouth bass (1987-2003 Avg. CPUE=1.014 bass/Rod-h); (Figure 3.3-11). Catch rates were highest during the period from 1995 to 2003 when diarists averaged 1.416 bass/Rod-h. Recently, catch rates have been about average for the time series (2000-2003 Avg. CPUE=1.170 bass/Rod-h).

New York has assessed its open lake smallmouth bass fishery since 1988. This fishery remains strong in eastern Lake Erie, with a long-term average CPUE of 0.83 bass/Rod-h (Einhouse *et al*. 2004). Catch rates have fluctuated over the time series. Bass anglers averaged about 0.6 bass/Rod-h from 1988 to1993. Catch rates increased considerably during the next few years (1994-1999) averaging 1.1 bass/rod-h and in the more recent time period (2000-2003) bass angler CUE's have been variable, but relatively good at an average 0.82 bass/rod-h.

Growth Status

Average size of age 0 bass in September (trawl catches) has fluctuated between 55 and 83 mm fork length (FL) across survey years, but in no discernable long-term trend (Figure 3.3-12). Increased size of age 0 bass after 2000 is coincident with colonization of eastern Lake Erie by round goby which may have provided an additional and abundant forage item for bass. Round goby abundance in Long Point Bay increased rapidly after 1999 (Figure 3.8-1). A recent study by Steinhart *et al*. (2004) indicates that the highly abundant round goby has accelerated the transition to piscivory for age 0 smallmouth bass, resulting in faster growth rates and larger size of bass at the end of their first growing season. An increase in size of age 0 bass from 2000 to 2003 is clearly evident in the Long Point Bay data (Figure 3.3-12). The dramatic decrease in size of age 0 bass during 2004 is in part explained by the unusually cool summer. First year growth of smallmouth bass is highly dependant on summer water temperatures; size of age 0 bass wass significantly correlated ($r=0.898$; $P \leq 0.05$) with mean summer (July-August) water temperature (Figure 3.3-13).

Information describing the growth of smallmouth bass comes from agency index gill net surveys and sampling of angler harvest. Figure 3.3-14 illustrates size-at-age for 2 to 5 year old smallmouth bass from the Outer Long Point Bay Index Gillnet Survey. For each of these four age cohorts there appears to be a decreasing trend in size-at-age during the early years in the time series that is followed by a trend of increasing size-at-age during the more recent time period (Figure 3.3-14). The inflection point, where trend lines change from decreasing to increasing, appears associated with recruitment of the 1991 year class. The significance of this is not clear but, it coincides with the basin-wide colonization of dreissenid mussels.

The Ontario partnership gillnet survey also shows that size-at-age of smallmouth bass has increased during the data series (Figure 3.3-14), with some of the highest observed sizes being observed recently. Growth of smallmouth bass in New York waters has been variable across survey years with no discernable pattern until after 1996 (Einhouse *et al*. 2004)., with average size of 2- and 3-year old bass increased between 1997 to 2003. Average size of age 2 bass in New York Waters during this time period falls within a range observed in previous years. However, the average size of age 3 bass during this period was the highest observed in the time series (1986- 2004).

Taken together, these data indicate the smallmouth bass populations of eastern Lake Erie are healthy and contribute to strong angling fisheries.

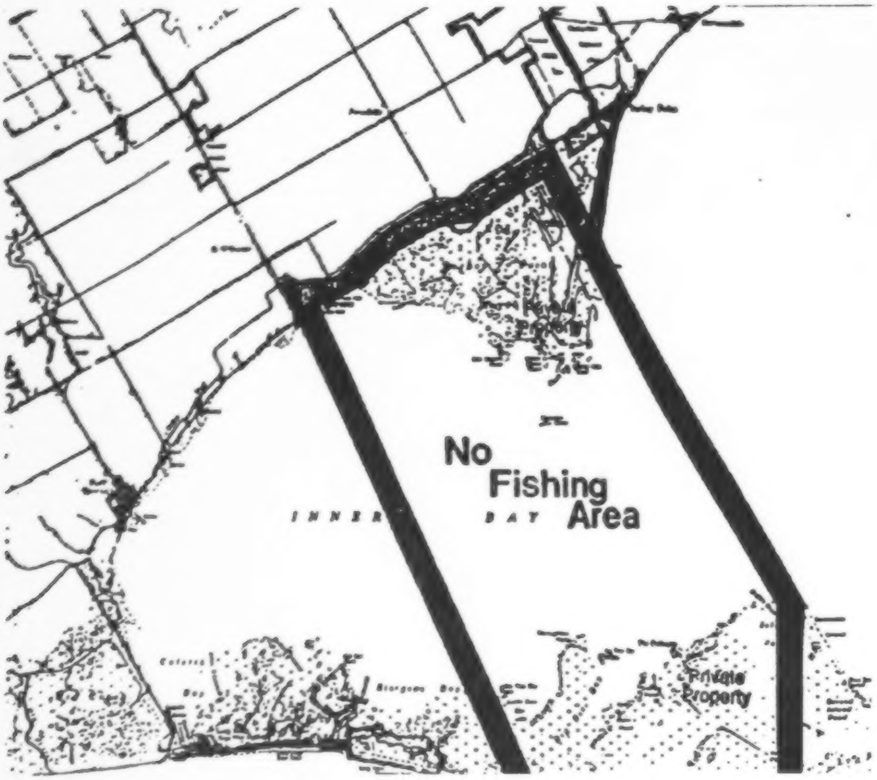

No Fishing Area
INNER BAY
Private Property
Private Property

Figure 3.3-1. Inner bay fish sanctuary of Lake Erie. No fishing between May 15 to the last Saturday in June each year.

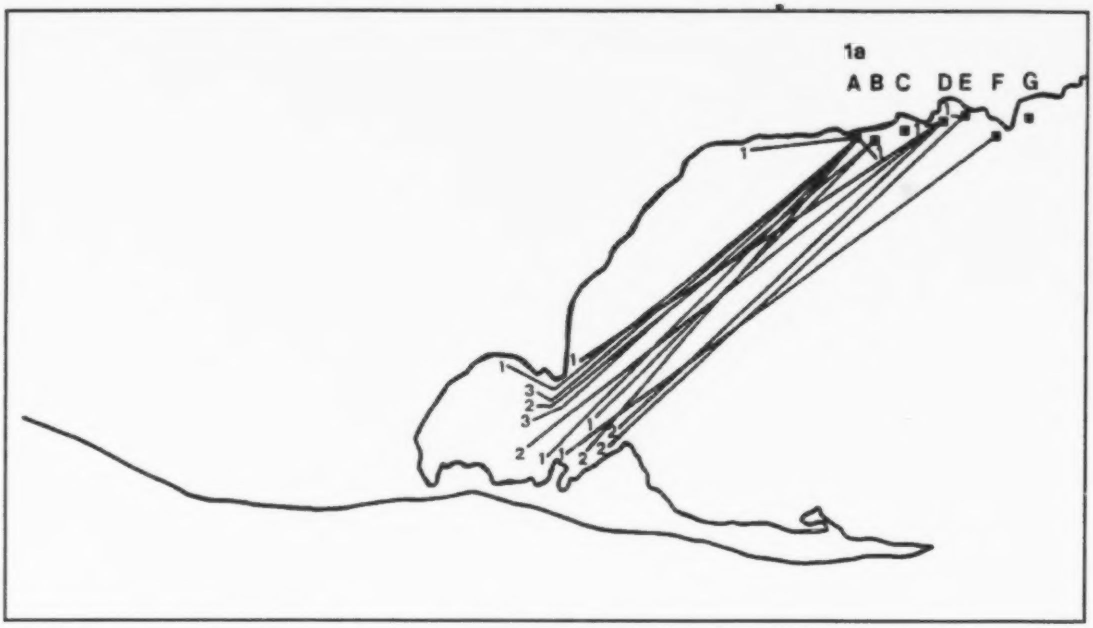


Figure 3.3-2. Tagged smallmouth bass recaptures from Nanticoke Fish Study trapnet monitoring sites along the north shore of Long Point Bay, 1981-83. Trapnet locations are represented by capital letters A to G. Superscripts above trapnet location denote the number of perch recaptured and their release locations Figure reproduced from MacGregor and Witzel 1987.

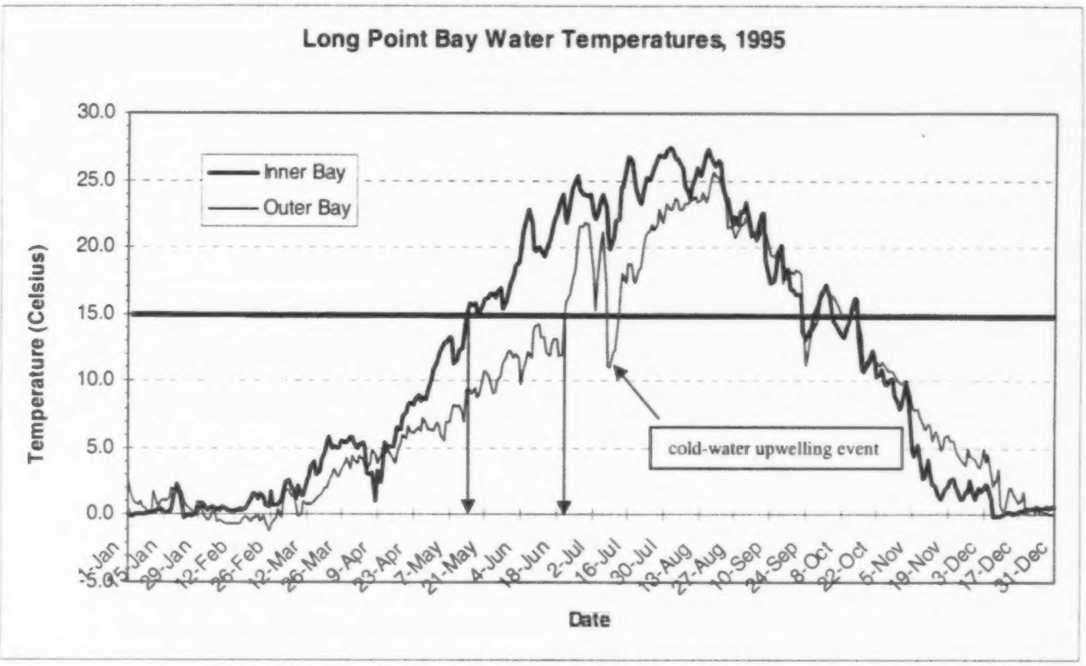


Figure 3.3-3. Comparison of water temperatures of Inner and Outer Long Point Bay, 1995. Date that daily mean temperatures first reached 15° C (denoted by arrows) was May 14th in Inner Bay and June 21st in Outer Bay.

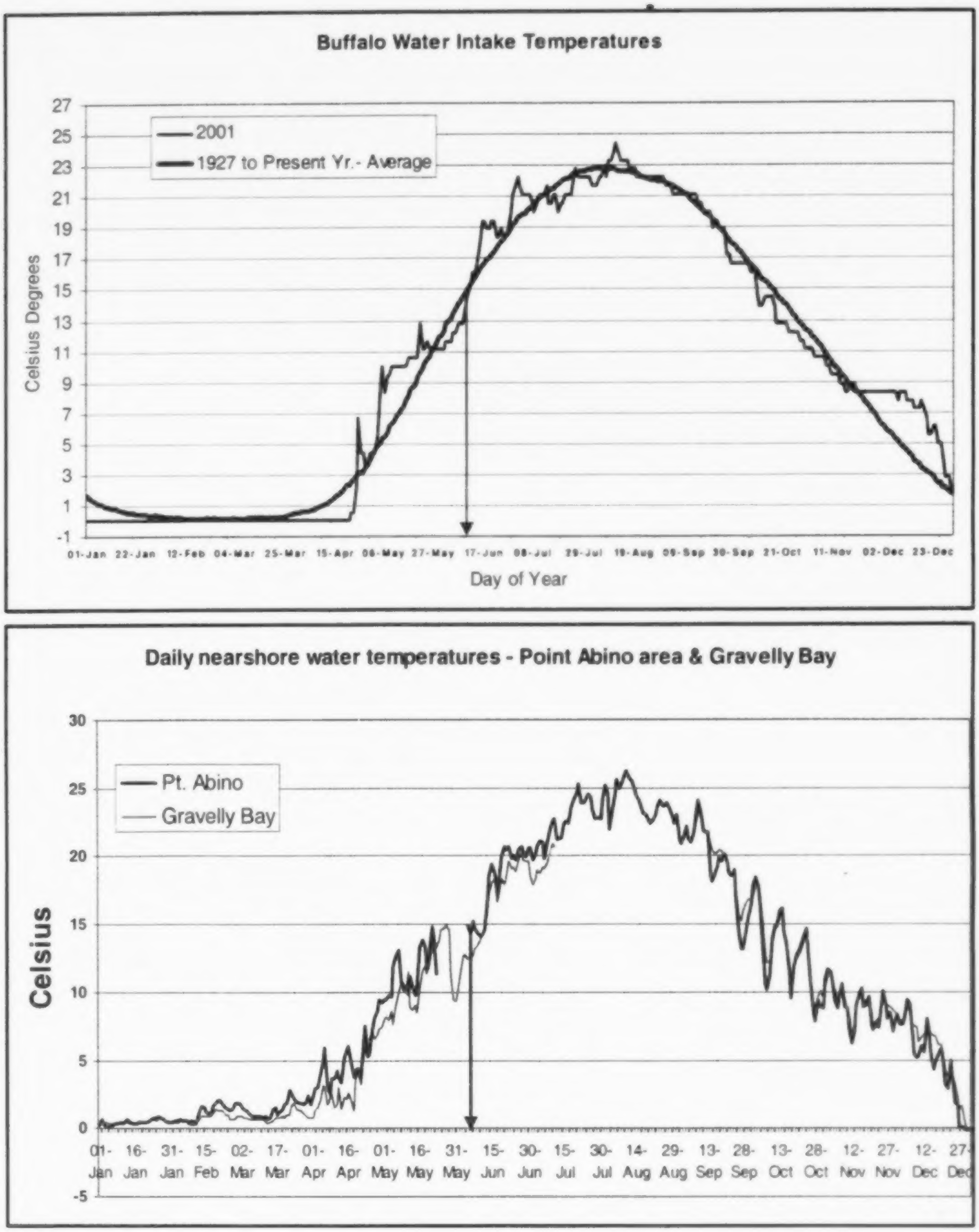


Figure 3.3-4. Daily water temperatures observed at the Buffalo, NY municipal water intake (upper graph) and two nearby north shore locations at Point Abino and Port Colborne, 2001. Temperature data for the Buffalo station were provided by T. Niziol, NOAA (pers. Comm).

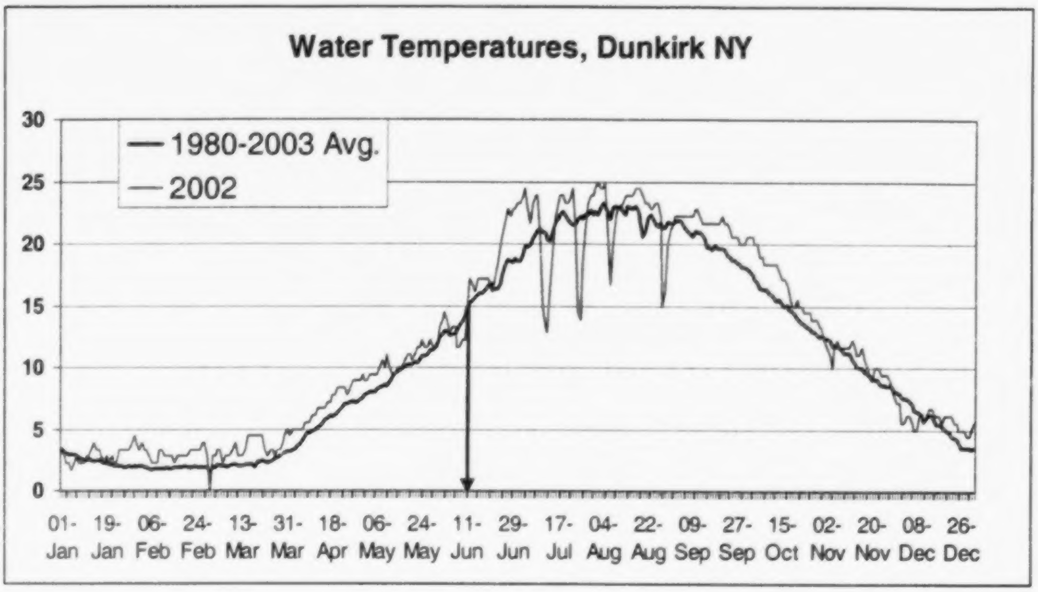


Figure 3.3-5. Daily water temperatures observed at the Dunkirk, NY municipal intake, 2002 and long-term average. Date associated with 15° C was June 11th. Note cold-water events during July and August, 2002. Data provided by D. Einhouse (NYSDEC)(pers. comm.).

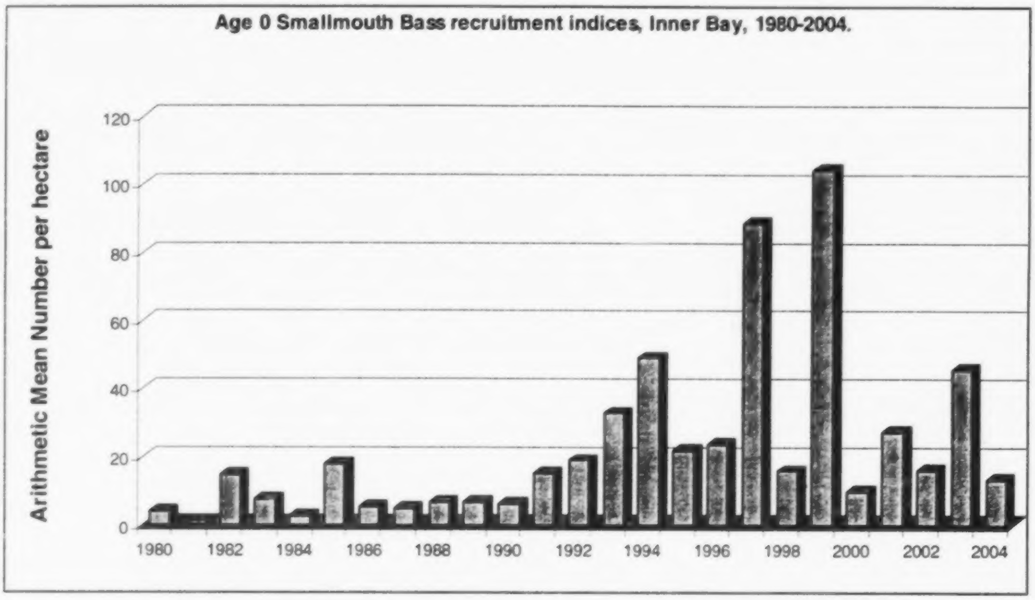
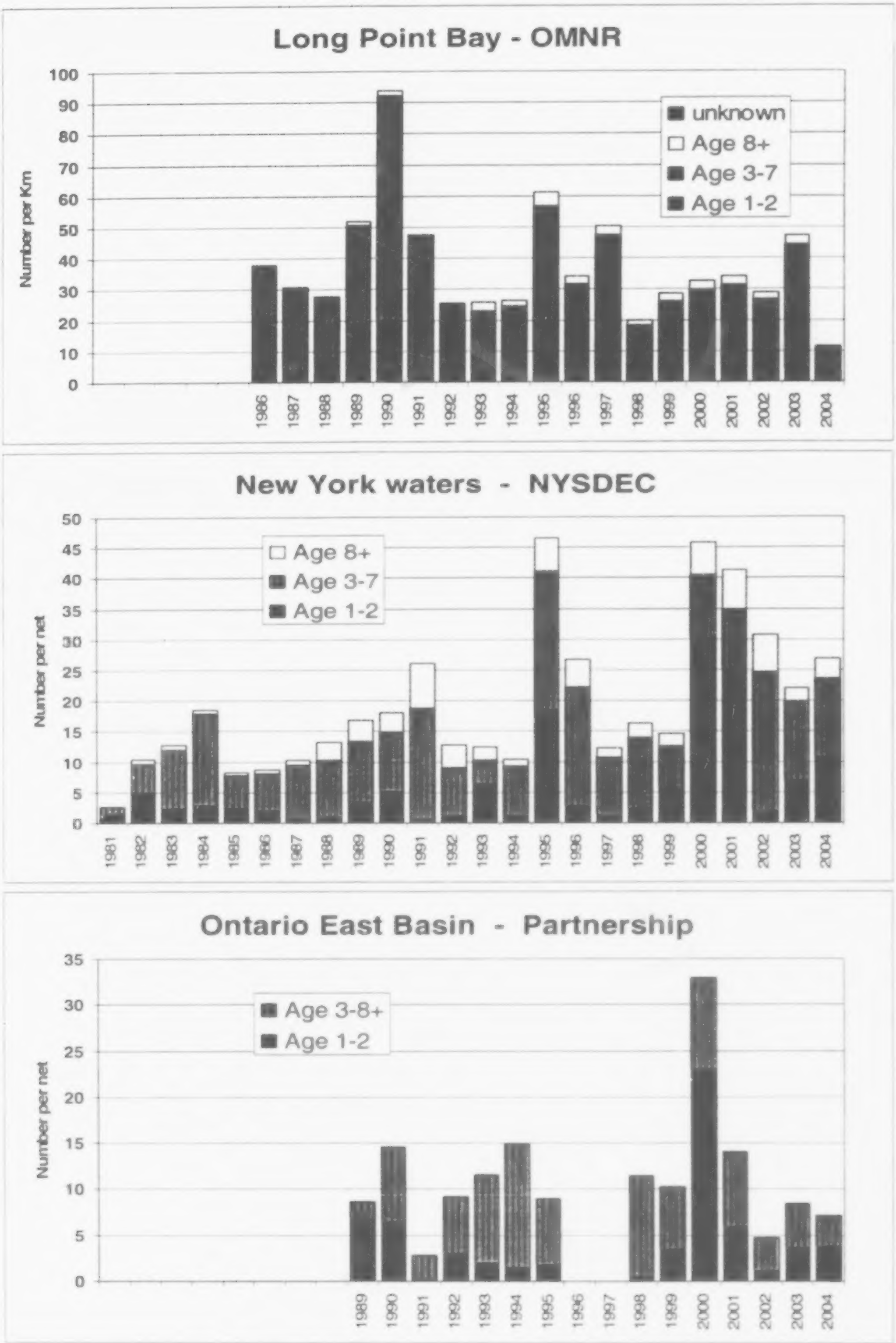


Figure 3.3-6. Relative abundance of age 0 smallmouth bass in index trawl catches, Inner Bay, Long Point Bay, Lake Erie, 1980-2004.


Long Point Bay - OMNR

New York waters - NYSDEC

Ontario East Basin - Partnership

Figure 3.3-7. Relative abundance of smallmouth bass (number per net or km) by age group from three independent agency index gillnet surveys in eastern Lake Erie.

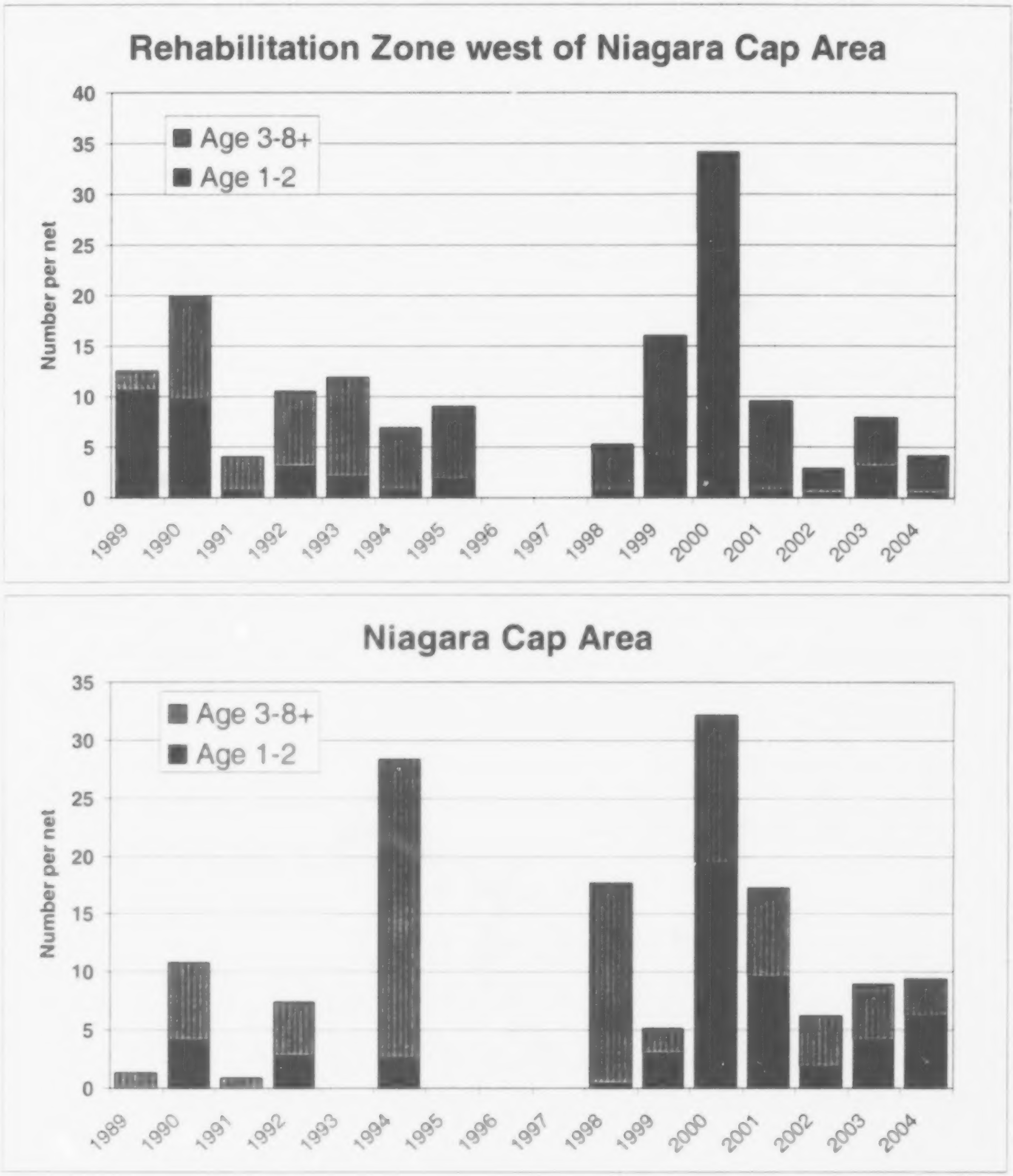


Figure 3.3-8. Relative abundance of smallmouth bass (number per net) by age group from the eastern region of the rehabilitation zone (Niagara Cap Area) and the rehabilitation zone west of the Niagara Cap Area of Lake Erie, Ontario Partnership Index Gillnet Survey, 1989-2004. No survey was conducted during 1996 and 1997. Sample size in Niagara Cap Area was small in 1995.

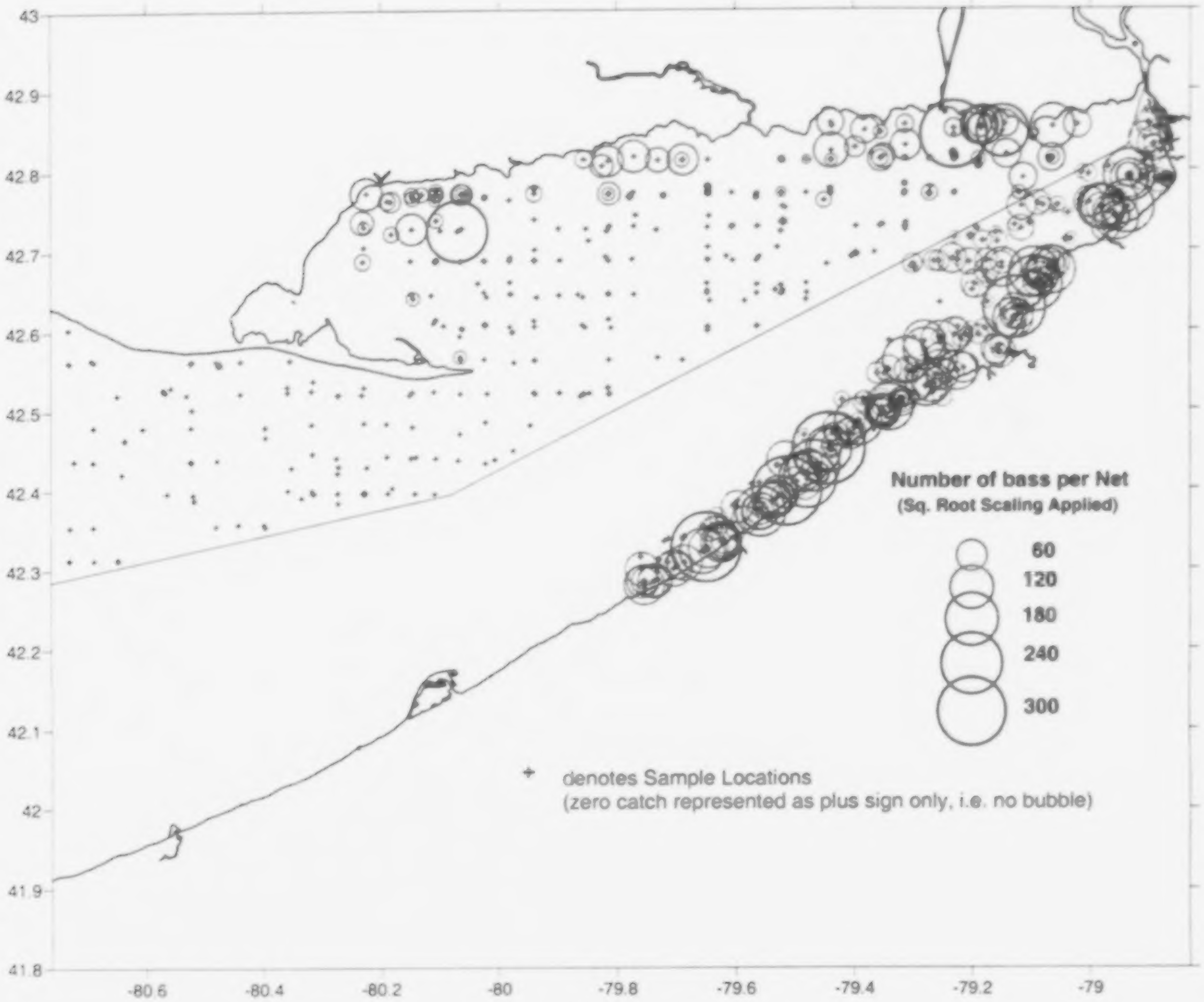

43
42.9
42.8
42.7
42.6
42.5
42.4
42.3
42.2
42.1
42
41.9
41.8
-80.6
-80.4
-80.2
-80
-79.8
-79.6
-79.4
-79.2
-79
Number of bass per Net
(Sq. Root Scaling Applied)
60
120
180
240
300
+ denotes Sample Locations
(zero catch represented as plus sign only, i.e. no bubble)

Figure 3.3-9. Spatial distribution of smallmouth bass in eastern Lake Erie from index gillnet surveys conducted in Ontario (Partnership Survey) and New York (NYSDEC Survey) waters. Relative abundance of bass is represented by size of bubble (Sq. Root Scaling applied). All gill net sets during 1998-2004 Partnership and 1998-2003 NYSDEC Surveys were mapped. Set locations are indicated by plus sign (+).

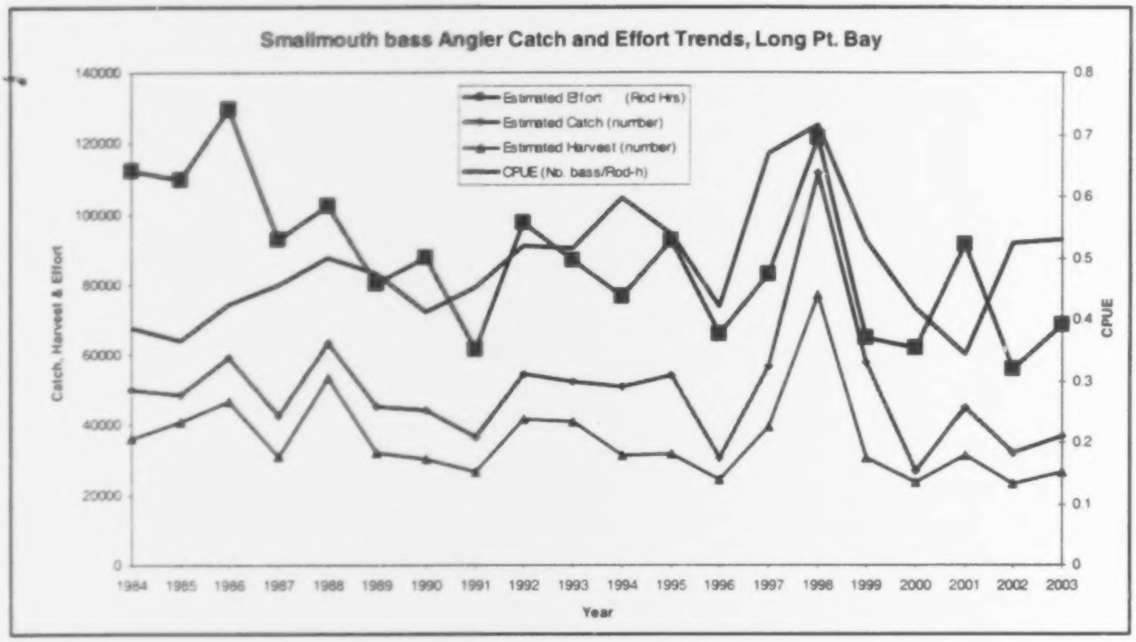
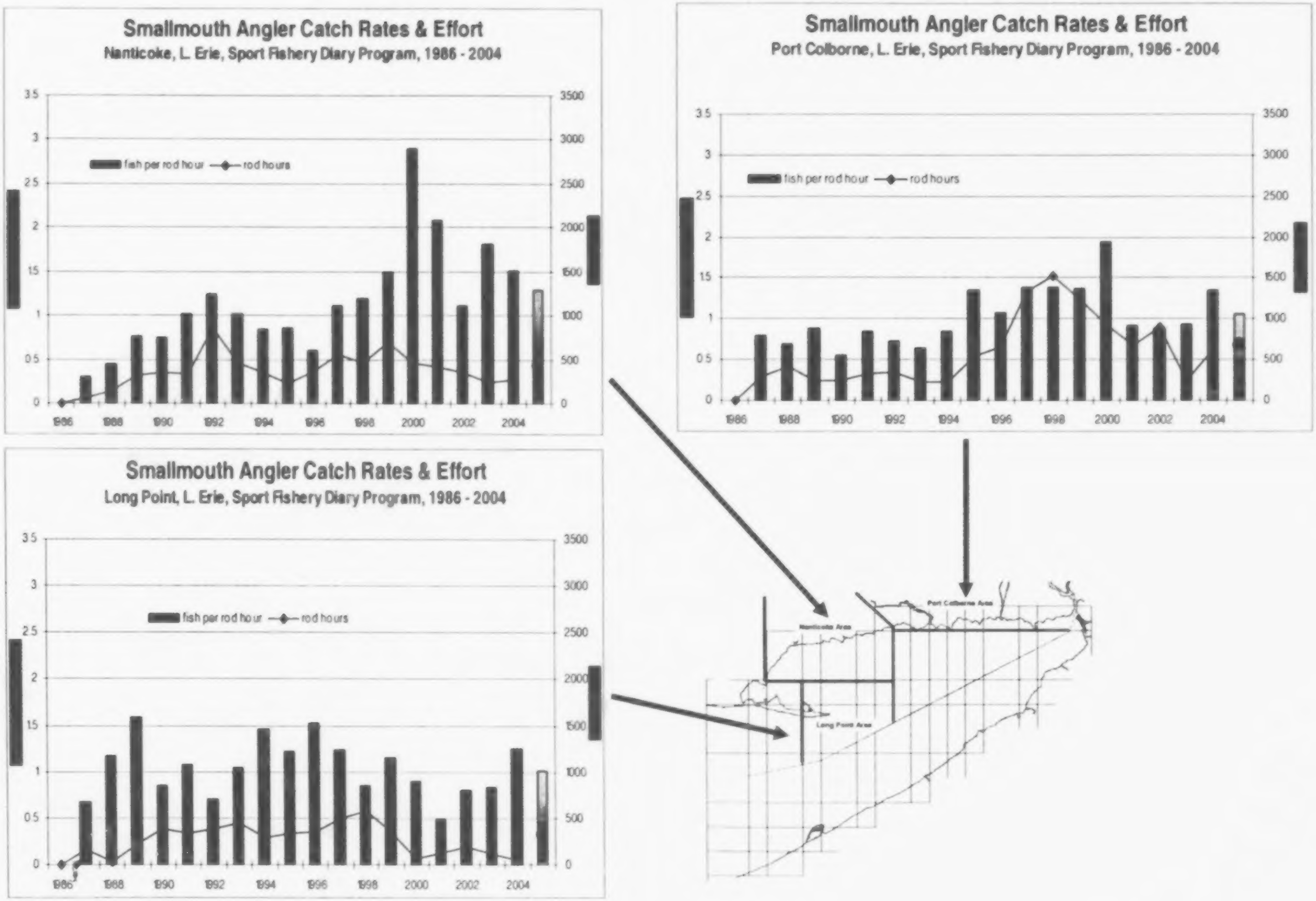


Figure 3.3-10. Estimated angling effort, catch, harvest, and CUE of smallmouth bass anglers in Long Point Bay, Lake Erie, 1984-2003.



Smallmouth Angler Catch Rates & Effort
Nanticoke, L. Erie, Sport Fishery Diary Program, 1986 - 2004

Smallmouth Angler Catch Rates & Effort
Port Colborne, L. Erie, Sport Fishery Diary Program, 1986 - 2004

Smallmouth Angler Catch Rates & Effort
Long Point, L. Erie, Sport Fishery Diary Program, 1986 - 2004

Figure 3.3-11. Smallmouth bass angler catch rates and directed effort of diarists in three Ontario areas of eastern Lake Erie, 1987-2003. Last column in graphs denotes average 1990-2003.

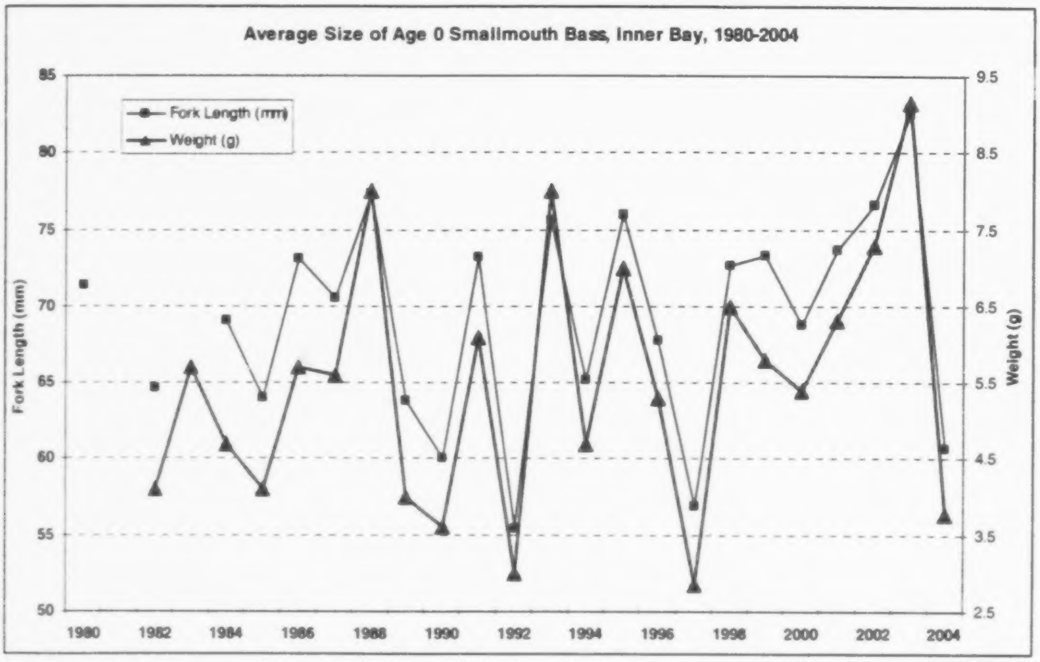


Figure 3.3-12. Average fork length (mm) and weight (g) of age 0 smallmouth bass in index trawl catches, Inner Long Point Bay, Lake Erie, 1980-2004.

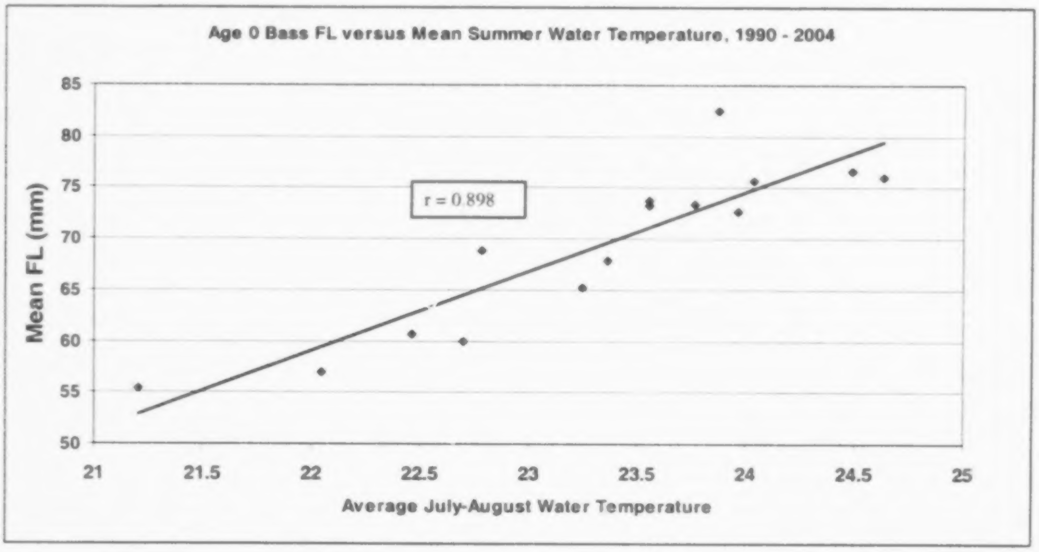


Figure 3.3-13. Relationship (shown as linear trend line) between annual mean size of age 0 smallmouth bass and mean water temperatures in Inner Long Point Bay, Lake Erie, 1990-2004.

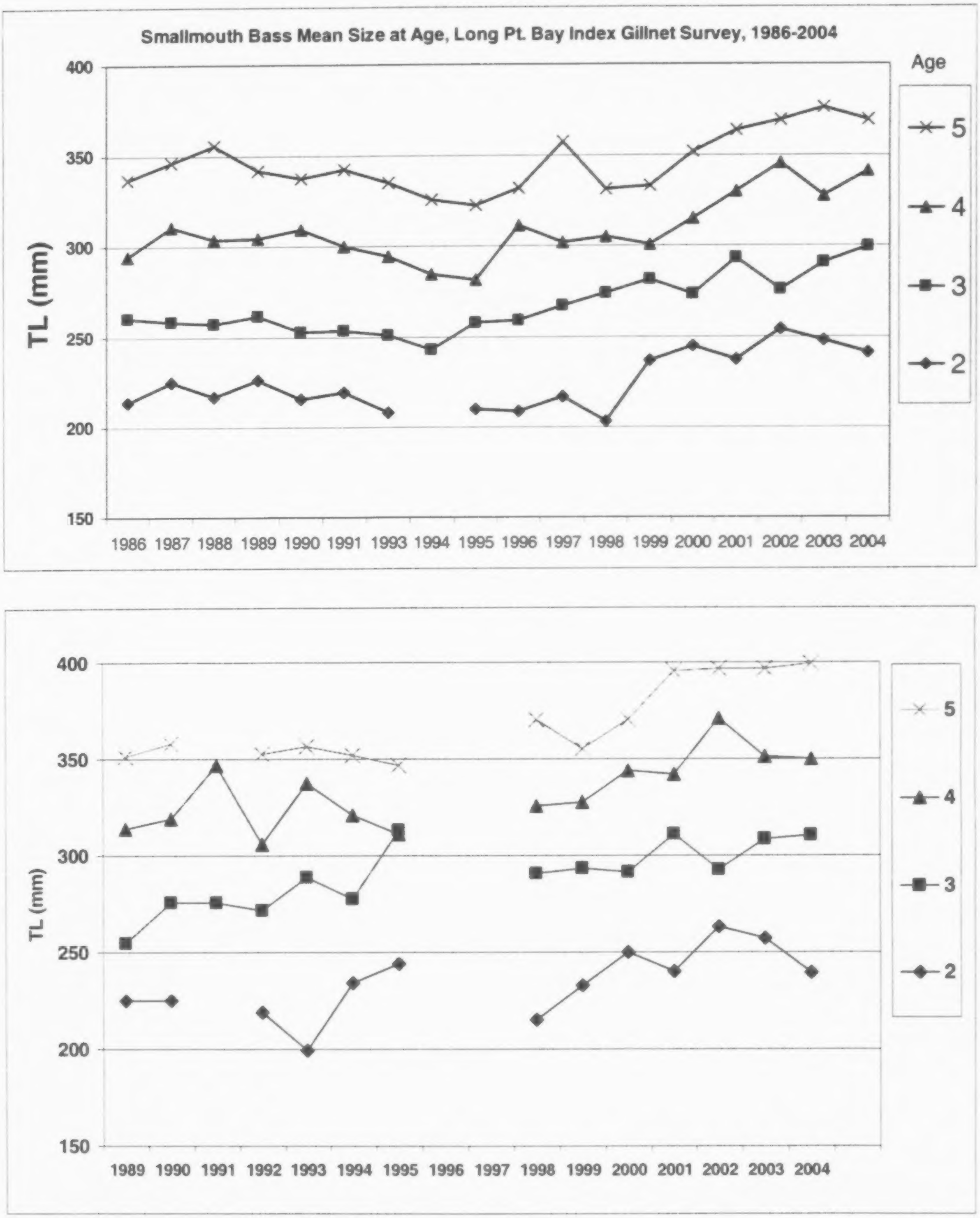


Figure 3.3-14. Mean size-at-age of smallmouth bass from annual catches in Long Point Bay and Ontario Partnership Index Gillnet Surveys, Lake Erie. Some data points are missing due to small sample size. Partnership Surveys were not conducted during 1996 and 1997.

3.4 Lake Whitefish

Lake whitefish undertake significant annual migrations within Lake Erie to complete their life history. The summer habitat for adult lake whitefish in Lake Erie is found in the deep waters of the eastern basin and adjacent waters of the central basin (Hardy 1994, Figure 3.4-1B). In the fall, after the lake turns over and cools, large numbers of whitefish migrate west, through the central basin to spawn during late November and December in the western basin. A reverse migration brings adult whitefish back to the eastern basin by the next summer.

The principal areas for whitefish reproduction are the shoal areas in western Lake Erie although historical spawning areas do exist in the eastern basin (Figure 3.4-1A). These areas apparently are not much used, since they do not attract targeted fishing. Catch data plotted for 1998 - 2004 suggests that the population density is very low. A population estimate was constructed for 2002 and for the years 1939-1953 for comparison (Stapanian *et al.* 2003). The commercial fishery in 2002 harvested 0.3 million fish, representing 22% of the population estimated at 1.33 million (adult) fish.

Hardy (1994) defined summer whitefish habitat as deeper than 20 m, which represents 386,700 ha in Ontario, New York and Pennsylvania waters. The 2002 population would have a density of 3.4 fish/ha in summer habitat (Figure 3.4-1A). During spawning, the fish would be concentrated in the western basin (124,700 ha) and have an average density of 10.7 fish/ha. Data from the Partnership index fishing survey (Markham *et al.* 2004) (Figure 3.4-2) show relatively low catch rates in eastern Lake Erie. An index of whitefish abundance from New York waters (Figure 3.4-3) shows some variation over time, but it is not consistent with the other index (Markham *et al.* 2004). The low density of fish in the lake makes it difficult to establish a reliable index of abundance.

Commercial fishing for whitefish occurs lakewide, but the bulk of the fishing effort takes place in the central and western basins during the annual spawning migration. In the east basin, whitefish are primarily harvested south of Long Point (figure 3.4-4). Until 2001, the Ontario commercial fishery harvest provided the best indicator of trends in the whitefish population (Figure 3.4-5). Recent data indicate that the population is in decline.

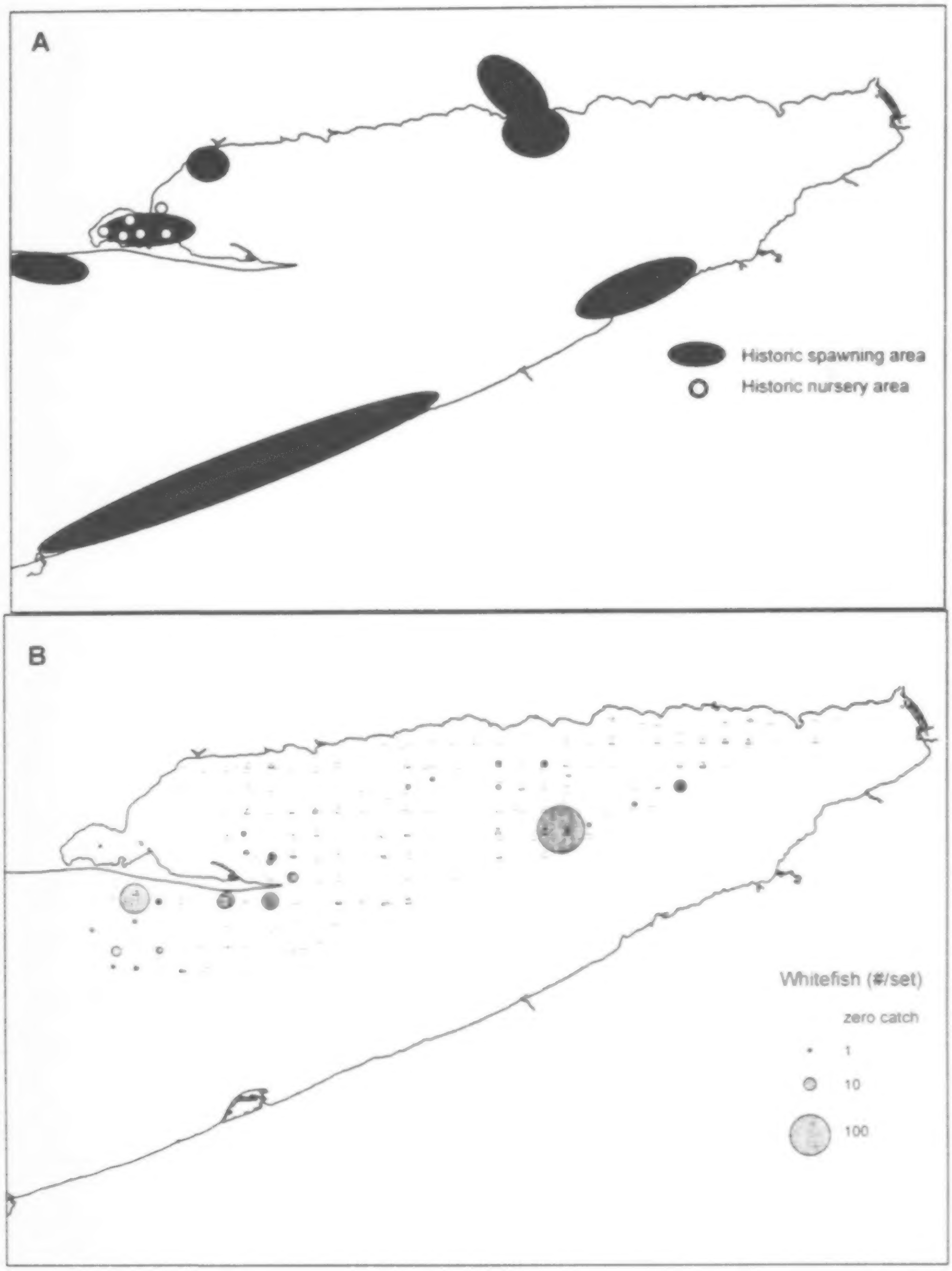

A
Historic spawning area
Historic nursery area
B
Whitefish (#/set)
zero catch
1
10
100

Figure 3.4-1. The eastern basin of Lake Erie, showing A) Historic whitefish spawning and nursery areas (reproduced from Goodyear *et al.* 1982) and B) gillnetting sites indicating catches of whitefish from the OMNR/OCFA Partnership index gillnetting program, 1998-2004. The relative size of each catch (#/set) is represented by the relative size of each circle as indicated.

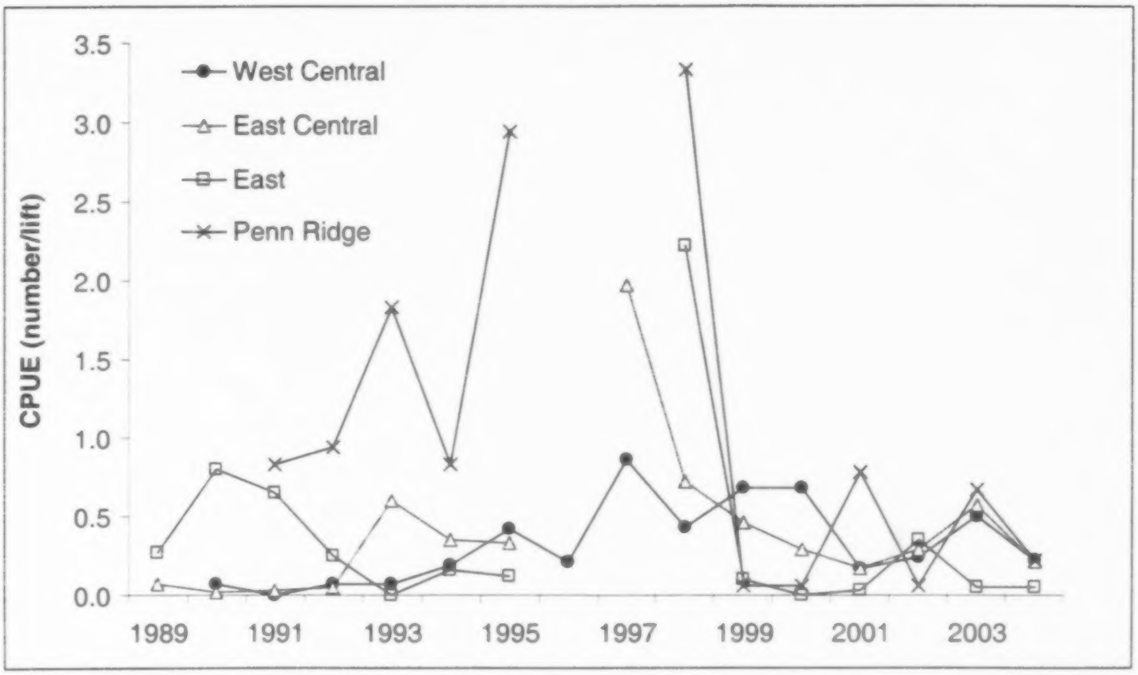


Figure 3.4-2. Catch rate (CPUE) (number per lift) of lake whitefish from Ontario Partnership index gillnetting by basin, Lake Erie, 1989-2004. West-central basin not surveyed in 1989. East-central basin not surveyed in 1996. East basin was not surveyed in 1996 and 1997; few sites were fished in 1995. Pennsylvania Ridge not surveyed in 1989, 1990, 1996, and 1997. Includes canned (suspended) nets. Standardized to equal effort among mesh sizes. Excludes thermocline sets (Markham *et al.* 2005).

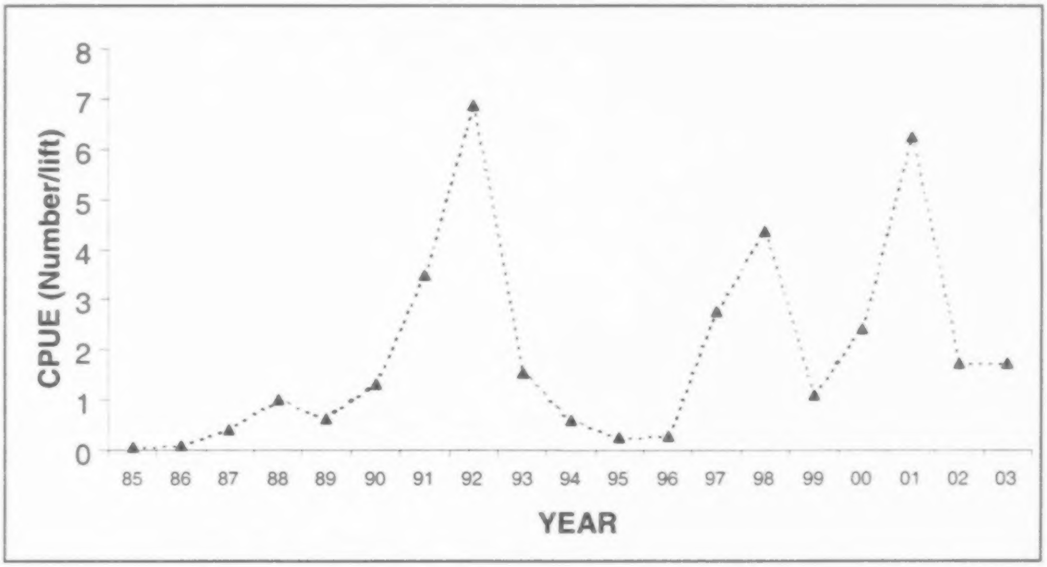


Figure 3.4-3. Catch per unit effort (CPUE) (number fish/lift) of lake whitefish caught in standard assessment gill nets from New York waters of Lake Erie, August, 1985-2003 (Markham *et al.* 2004).

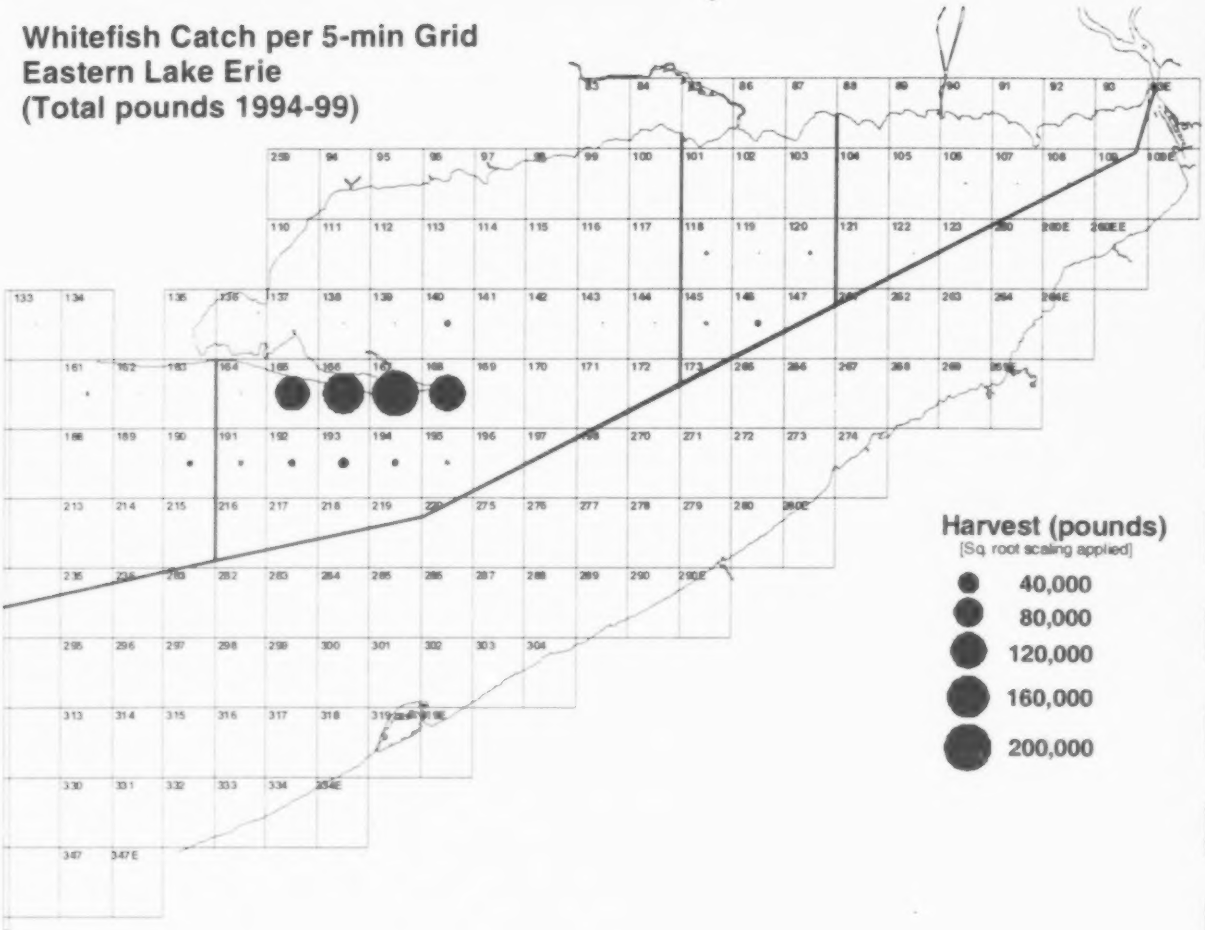

Whitefish Catch per 5-min Grid
Eastern Lake Erie
(Total pounds 1994-99)
Harvest (pounds)
[Sq. root scaling applied]
40,000
80,000
120,000
160,000
200,000

Figure 3.4-4. Commercial harvest of whitefish by grid for years 1994-99.

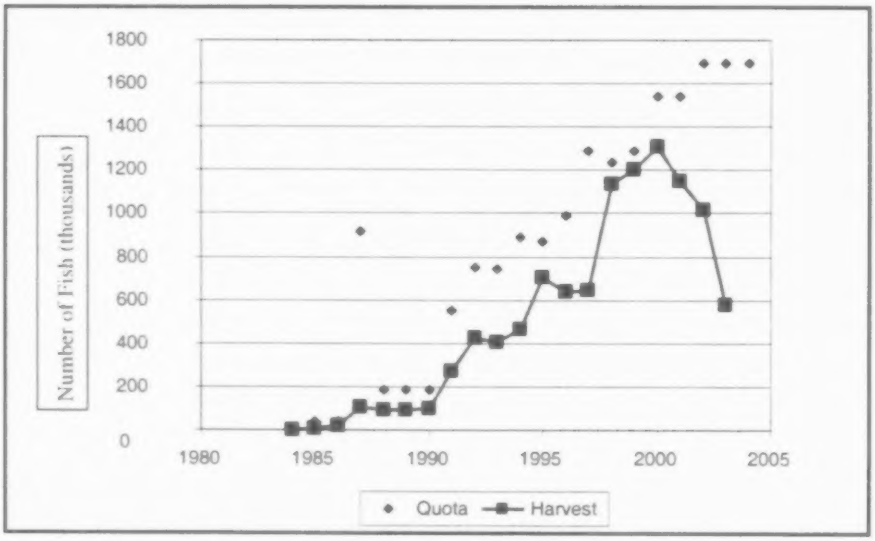


Figure 3.4-5. Ontario lake-wide commercial harvest and quota for lake whitefish.

3.5 Salmonids and Sea Lamprey

Lake Erie supported a native stock of lake trout in eastern Lake Erie (Cornelius *et al.* 1995) but by the 1930s the native stock had been extirpated and various stocking programs have attempted to re-establish lake trout. The latest initiative commenced in 1973 (Cornelius *et al.* 1995) and is directed towards re-establishment of a self-sustaining stock large enough to support the historical fishery, which averaged 45,360 kg per year in the last century. In 2003, 120,000 lake trout (yearling equivalents) were stocked (Table 3.5-1). The spatial pattern of lake trout in the lake can be described by catches in partnership index gillnet survey from 1998 - 2004 (Figure 3.5-1A). Although lake trout were caught in several locations in the east basin, the highest density occurs in the area south of Port Maitland. Ontario participates in an international coordinated assessment survey of lake trout abundance in the lake, which showed a major decline in abundance in the 1990s and a strong increase after 2000 (Figure 3.5-2) (Markham *et al.* 2004). The decline and recovery were a consequence of poor survival of stocked fish to age 2, during the 1990s.

Lake Erie supports naturalized stocks of Pacific salmon and brown trout. Coldwater streams in Long Point Bay support rainbow trout, coho salmon and pink salmon. A fishway was established on Big Creek at Delhi (Ontario) to facilitate rainbow trout access to upstream waters The Grand River, with its tributaries like Whiteman's Creek, supports rainbow trout and other pacific salmon. Naturalized stocks of rainbow trout and coho salmon have been established in tributaries in New York, Ohio, and Pennsylvania but their contribution to the lake population is unknown.

Management jurisdictions around Lake Erie reduced stocking levels in the 1990s; 2003 is the lowest year in the series (Table 3.5-1) with 2,057,729 fish stocked (yearling equivalents). Lake trout, rainbow trout, brown trout, coho and chinook salmon have been stocked at various ages. The expected survival rate of different stages, led to a standard reporting scheme as the equivalent number of fish stocked as spring yearlings. Ontario stocked 55,672 yearling fish (rainbow trout and brown trout) in 2003.

The distribution of rainbow trout has been shown using catch data from the Partnership index fishing survey (Figure 3.5-1B). There is no pattern apparent in the distribution. The angler diary program in Ontario is a valuable monitoring tool for the rainbow trout fishery (Figure 3.5-3). It shows that the strongest fishery is in Long Point Bay. Generally, CPUE has been higher in the late 1990s and 2000s.

Arnold (2004) estimated that 806 rainbow trout, 246 coho salmon, 210 chinook salmon, and 244 lake trout were caught in Ontario waters of the eastern basin during June, July and August of 2003. There was relatively little targeted effort recorded for lake trout, but anglers caught 1.538 fish/rod-hour.

The survival of salmonids, lake whitefish, and burbot can be adversely affected by sea lamprey predation. Stocked lake trout exhibited a high wounding rate in the 1980s (Figure 3.5-4), but was reduced after sea lamprey control practices were instituted in 1987 (Markham *et al.* 2004). The population of sea lamprey was estimated to range between 2000 and 17,000 lamprey between 1980 and 2003 (Figure 3.5-5). Control programs involving controlled application of lampricide to streams are undertaken as threshold population levels of ammocoetes (juvenile lamprey) are reached in the 20 lamprey-producing streams around the basin (Figure 3.5-6). Access to spawning habitat in Lake Erie tributaries has been denied by dams in the Grand River (Ontario) and an inflatable barrier in Big Creek, Ontario.

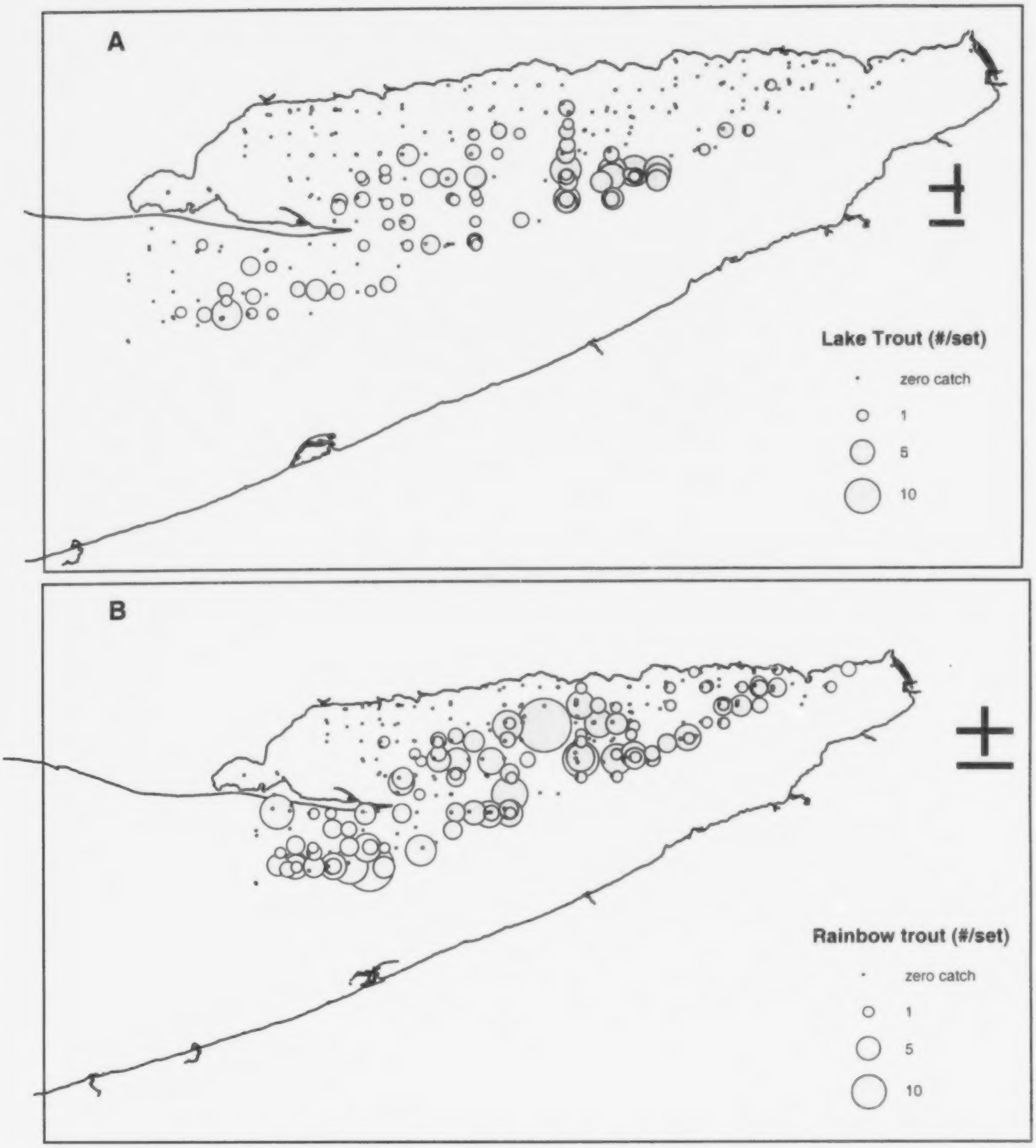

A
Lake Trout (#/set)
zero catch
1
5
10
B
Rainbow trout (#/set)
zero catch
1
5
10

Figure 3.5-1. Lake Erie, eastern basin gillnetting sites indicating catches of Lake trout and Rainbow trout from the OMNR/OCFA Partnership index gillnetting program, 1998-2004

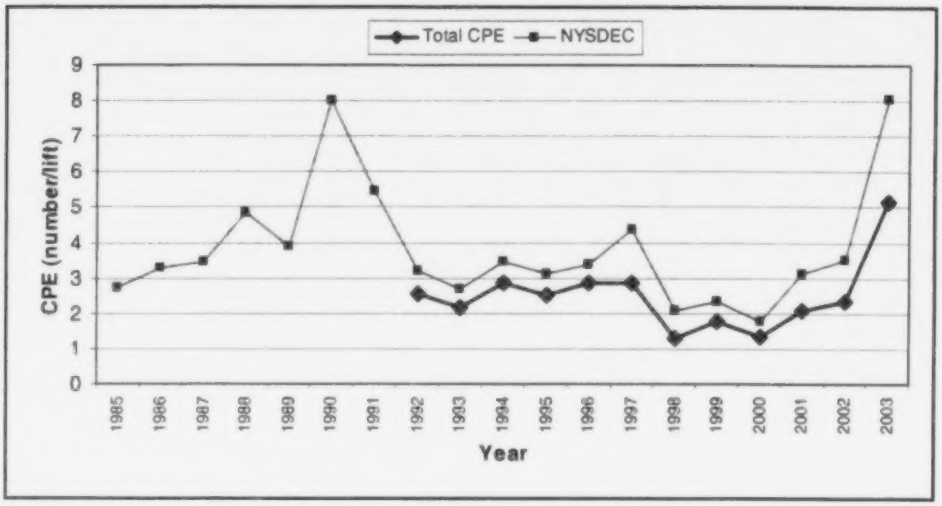


Figure 3.5-2. Relative abundance (number fish/lift) of lake trout caught in standardized gillnet assessment surveys from the eastern basin of Lake Erie, 1992-2003. The NYSDEC series from 1985-2003 is also shown for reference to a longer time-series (Markham *et al.* 2004).

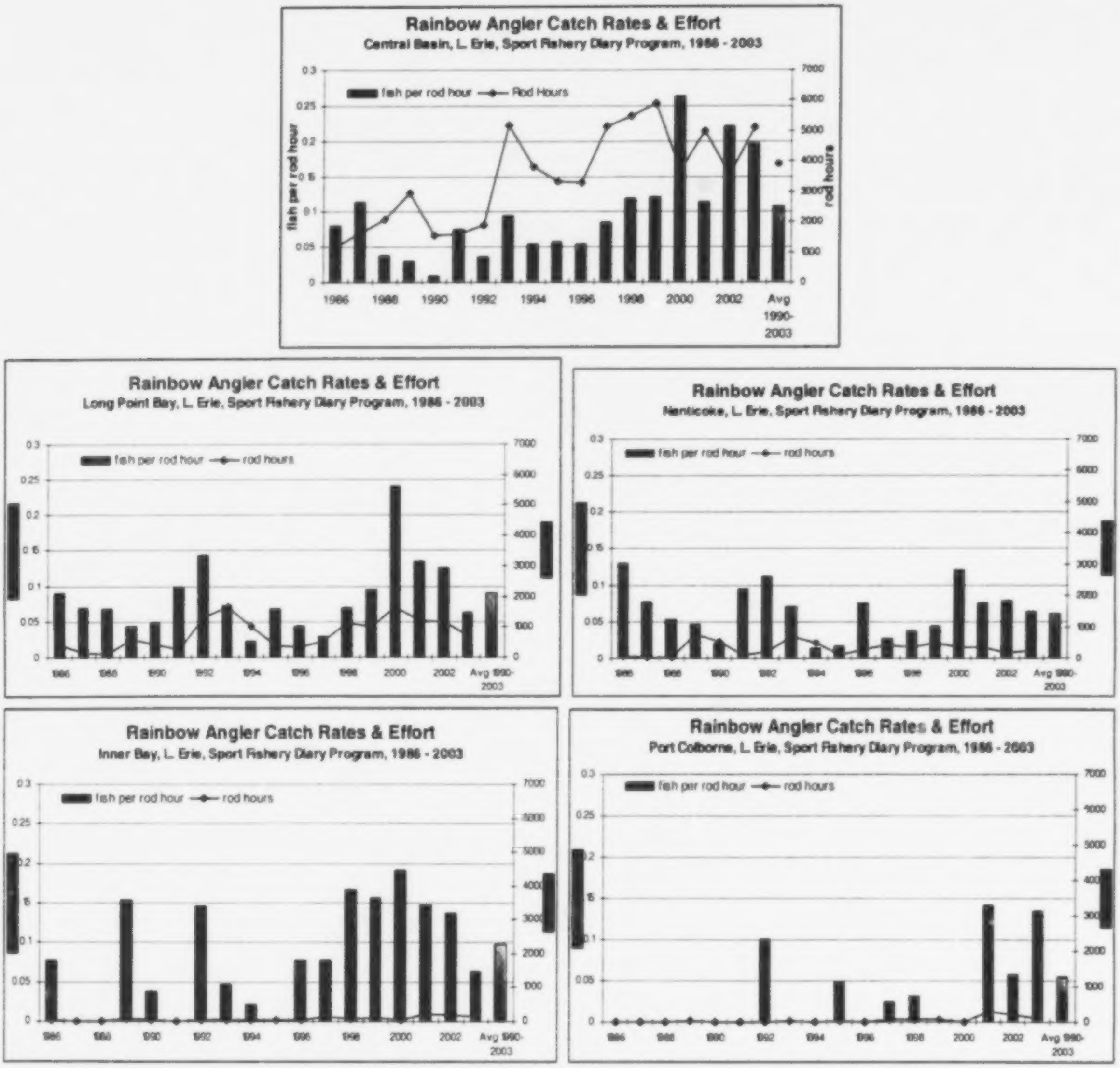


Figure 3.5-3. Observations of angler CPUE and sample effort from angler diary participants targeting rainbow trout, by area (1986-2003). Last column in graphs denotes average 1990-2003.

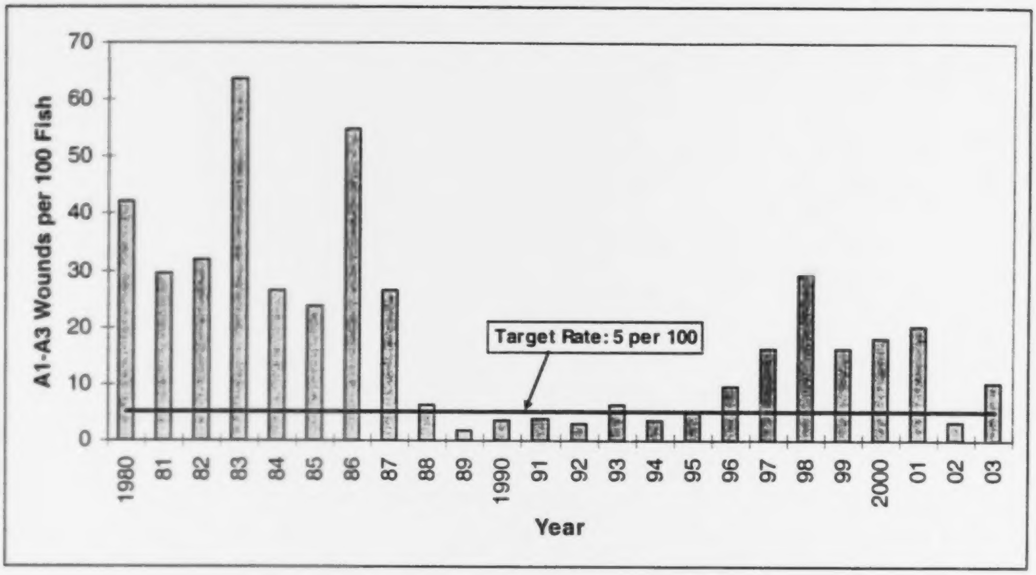


Figure 3.5-4. Number of fresh (Type A1-A3) sea lamprey wounds per 100 adult lake trout greater than 21 inches (532 mm) sampled in standard assessment gill nets from New York waters of Lake Erie, August, 1980-2003. The Strategic Plan target rate is 5 wounds per 100 fish (Markham *et al*. 2004).

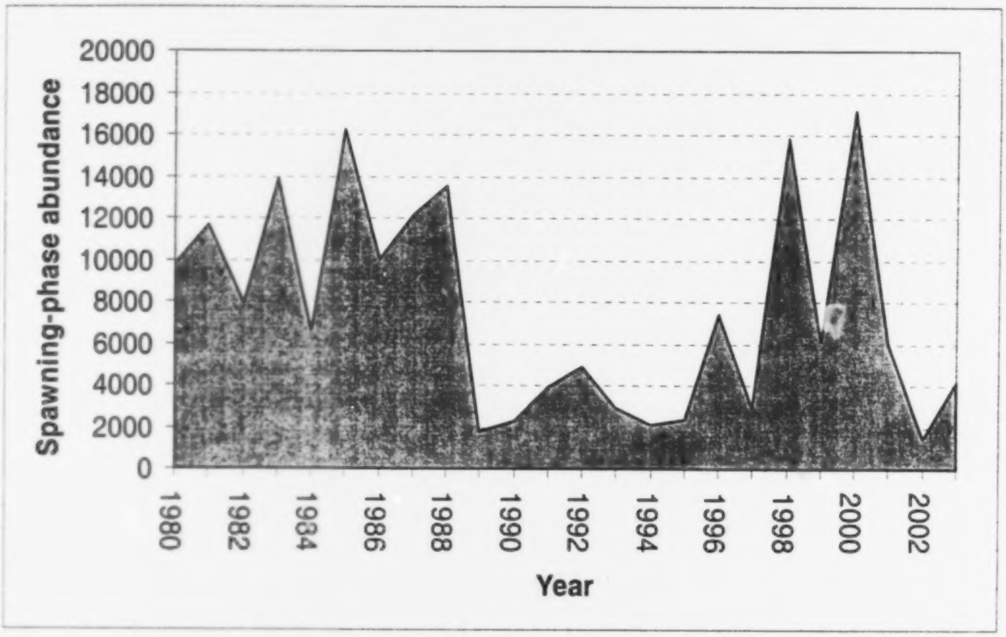


Figure 3.5-5. Lakewide estimate of spawning-phase sea lampreys in Lake Erie, 1980-2003 (Markham *et al*. 2004).

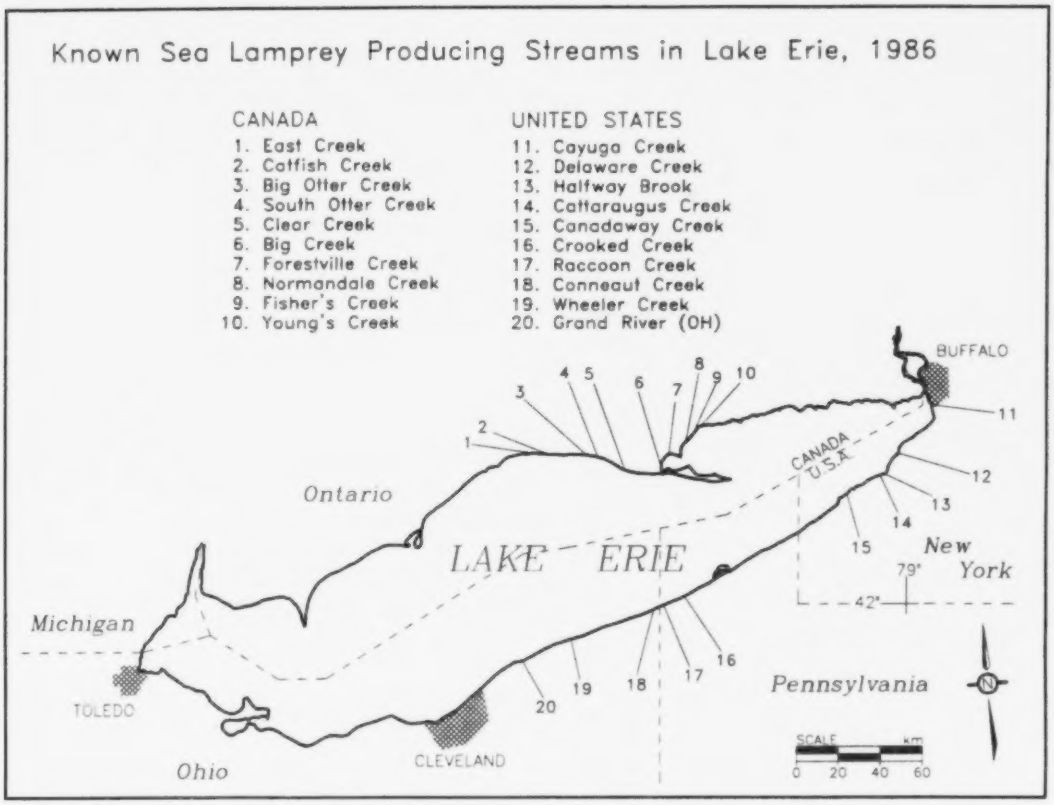

Known Sea Lamprey Producing Streams in Lake Erie, 1986
CANADA
1. East Creek
2. Catfish Creek
3. Big Otter Creek
4. South Otter Creek
5. Clear Creek
6. Big Creek
7. Forestville Creek
8. Normandale Creek
9. Fisher's Creek
10. Young's Creek
UNITED STATES
11. Cayuga Creek
12. Delaware Creek
13. Halfway Brook
14. Cattaraugus Creek
15. Canadaway Creek
16. Crooked Creek
17. Raccoon Creek
18. Conneaut Creek
19. Wheeler Creek
20. Grand River (OH)
BUFFALO
Ontario
CANADA
U.S.A.
LAKE ERIE
New York
79°
42°
Michigan
TOLEDO
Pennsylvania
N
CLEVELAND
Ohio
SCALE km
0 20 40 60

Figure 3.5-6. Lake Erie streams with known production of lamprey as of 1986. Image courtesy of Sullivan P and Hallet A, DFO sea lamprey control, 2003 (pers. comm.).

Table 3.5-1. Summary of salmonid stocking in number of yearling equivalents, Lake Erie 1998-2003 (Markham *et al.* 2004).

Jurisdiction	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
ONTARIO	--	--	--	--	61,000	61,000
NEW YORK	106,900	--	--	--	299,610	406,510
PENNSYLVANIA	--	100,000	--	28,030	1,271,651	1,399,681
OHIO	--	--	--	--	266,383	266,383
MICHIGAN	--	--	--	--	60,030	60,030
1998 Total	**106,900**	**100,000**	**0**	**28,030**	**1,958,674**	**2,193,604**
ONTARIO			--		85,235	85,235
NEW YORK	143,320		--		310,300	453,620
PENNSYLVANIA	40,000	100,000	--	20,780	835,931	996,711
OHIO			--		238,467	238,467
MICHIGAN			--		69,234	69,234
1999 Total	**183,320**	**100,000**	**0**	**20,780**	**1,539,167**	**1,843,267**
ONTARIO	--	--	--	--	10,787	10,787
NEW YORK	92,200	--	--	--	298,330	390,530
PENNSYLVANIA	40,000	137,204	--	17,163	1,237,870	1,432,237
OHIO	--	--	--	--	375,022	375,022
MICHIGAN	--	--	--	--	60,000	60,000
2000 Total	**132,200**	**137,204**	**0**	**17,163**	**1,982,009**	**2,268,576**
ONTARIO	--	--	--	100	40,860	40,960
NEW YORK	80,000	--	--	--	276,300	356,300
PENNSYLVANIA	40,000	127,641	--	17,000	1,185,239	1,369,880
OHIO	--	--	--	--	424,530	424,530
MICHIGAN	--	--	--	--	67,789	67,789
2001 Total	**120,000**	**127,641**	**0**	**17,100**	**1,994,718**	**2,259,459**
ONTARIO	--	--	--	4,000	66,275	70,275
NEW YORK	80,000	--	--	72,300	257,200	409,500
PENNSYLVANIA	40,000	100,289	--	40,675	1,145,131	1,326,095
OHIO	--	--	--	--	411,601	411,601
MICHIGAN	--	--	--	--	60,000	60,000
2002 Total	**120,000**	**100,289**	**0**	**116,975**	**1,940,207**	**2,277,471**
ONTARIO	--	--	--	7,000	48,672	55,672
NEW YORK	120,000	--	--	44,813	253,750	418,563
PENNSYLVANIA	--	69,912	--	22,921	866,789	959,622
OHIO	--	--	--	--	544,280	544,280
MICHIGAN	--	--	--	--	79,592	79,592
2003 Total	**120,000**	**69,912**	**0**	**74,734**	**1,793,083**	**2,057,729**

3.6 Rainbow Smelt and Alewife

Rainbow smelt is an exotic species that was first recorded in Lake Erie in 1935 (Van Oosten 1937). A commercial fishery for rainbow smelt developed in the late 1950s as the smelt population apparently increased in biomass. Smelt were harvested first using pound nets and gill nets, and beginning in the early 1960s using bottom trawls (MacCallum and Regier 1970; Hartman 1972; Leach and Nepszy 1976). There is no evidence of discrete stocks; however, growth patterns (MacCrimmon *et al.* 1983) and temporal trends in abundance (OMNR unpubl. data) have varied between basins, indicating that smelt stocks should be managed separately by basin.

Harvests of smelt from 1990 to 2003 from eastern Lake Erie are shown in Figure 3.6-1. It is difficult to interpret these as trends in biomass, due to the nature of the commercial fishery and economic factors that favour harvesting from OE 3 (Elgin County) waters. A trawl index of young-of-the-year smelt abundance provides a measure of recruitment (Figure 3.6-2), which shows that reproduction was extremely depressed in the 1990s (1993-2000), and only recovered in 2001. Survival rate estimates for smelt were developed from commercial harvest samples (Ryan *et al.* 1999) and ranged from 35-45% during the years 1976 to 1984, from 17-34% during the years 1985-1992, and from 5-18% during the years 1993-1995.

Smelt are an important food item for walleye and stocked salmonines in eastern Lake Erie (Einhouse *et al.* 1993). During the 1980s and early 1990s, the survival rate for smelt declined as walleye abundance increased in eastern Lake Erie. When predator demands on forage species (Einhouse *et al.* 1993) were compared with commercial harvest, they indicated that fish predators (excluding burbot) used approximately 55% of the smelt, while the trawl fishery used 45% for the years 1985 to 1991 (Einhouse *et al.* 1993).

The aquatic food web in Lake Erie was substantially altered after the arrival of rainbow smelt. Opossum shrimp (*Neomysis integer*), a preferred food item in the Great Lakes and inland lakes, were abundant in 1928 and 1929 in eastern Lake Erie (Fish *et al.* 1960), but were rare in surveys in the 1960s and later (Johannsson *et al.* 1999). Analyses of smelt stomachs in the 1960s (Dermott *et al.* 1999) and 1970s (Henderson and Nepszy 1989) did not show shrimp in the diet. These shrimp are important food items for deepwater sculpin (*Myoxocephalus thompsoni*) (Parker 1988) and long-jaw cisco (*Coregonus alpenae*) (Campbell 1987), two species that are virtually extinct and extinct, respectively in Lake Erie. The deepwater amphipod (*Diaporeia*) is also an important food for these species, but has a limited distribution (Dermott 1994) and, like opossum shrimp, is also a preferred food item for smelt. Smelt may have been responsible for preventing the recovery of the lake herring stock (Leach and Nepszy 1976) and the lake whitefish stock (Hardy 1994). Smelt also have been implicated in the recruitment failure of blue-pike (Regier *et al.* 1969). In addition, smelt contain enough thiaminase to affect the fertility of salmonid eggs (J. Fitzsimmons, Department of Fisheries and Oceans, Burlington, ON, pers. comm.). The comparatively low hatch success of eggs (approximately 50%) collected from stocked lake trout in Lake Erie may be an indication of the effect of an unfavourable diet.

Alewife is also an invasive species in Lake Erie. Data from the Nanticoke Fish Study (MacGregor and Witzel 1987), and the Long Point Bay Gillnet Survey (Figure 3.6-3) show that yearling and older alewife populations undergo extreme fluctuations in abundance (Ryan *et al.* 1999) making this species a unstabel source of forage. Alewife are vulnerable to the extremely cold winter temperatures that Lake Erie can experience. A number of invasive species are not tolerant of such cold temperatures. Colby (1973) found that alewife began to die when the water temperature reached 3.4°C, and

McCauley and Binkowski (1982) estimated the ultimate lower incipient lethal temperature as 2.5°C. These observations indicate that alewife will die under typical winter conditions in Lake Erie because they do not have access to deepwater thermal refugia as are available in other Great Lakes (e.g. Lake Ontario as described by Bergstedt and O'Gorman 1989), or as created by reverse stratification in lakes with stable ice cover. Winter mortality of alewife has been observed by commercial trawl fishers (R. Misner, Port Dover, ON, pers. comm.) and fisheries biologists (R. Kenyon, PA. Fish & Boat Comm., Fairview, PA, USA, pers. comm.).

Alewife and smelt may affect the structure of the food web and are unstable as forage species. Smelt have been increasing in eastern Lake Erie, while alewife show fluctuations that are believed to be linked to adverse winter conditions.

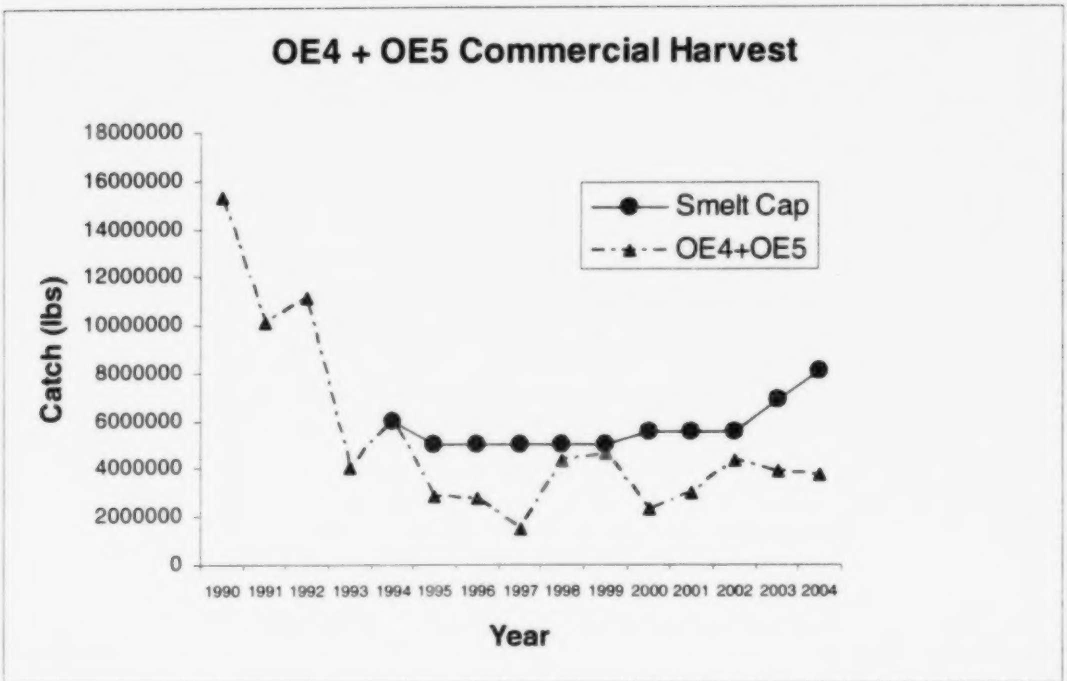


Figure 3.6-1. Trend in smelt harvest from the eastern basin 1990-2004. Separate harvest control system or cap was instituted in 1994.

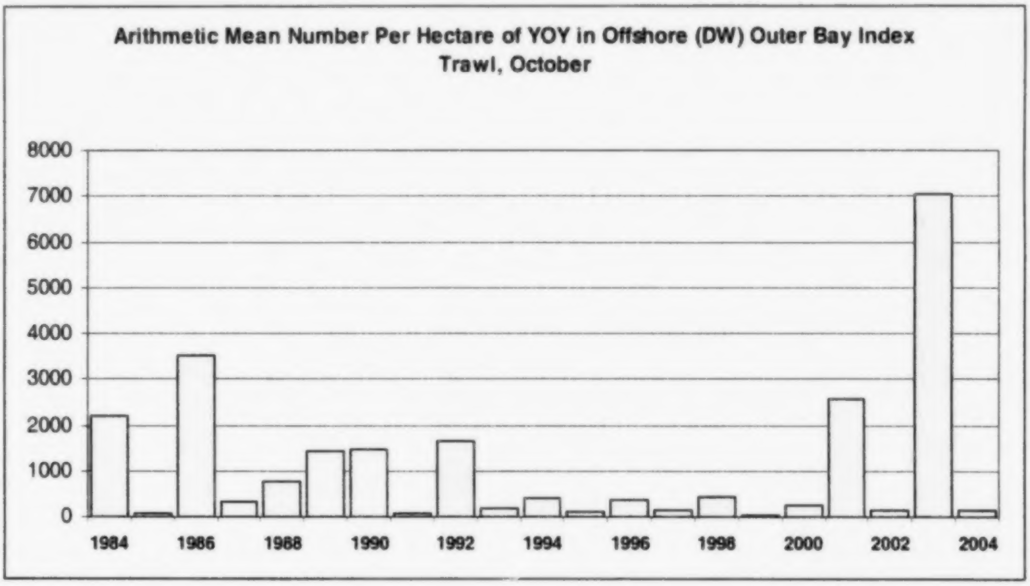


Figure 3.6-2. Young of year (YOY) density for rainbow smelt in Long Point Bay (1984-2004), from deepwater (DW) offshore outer bay trawls.

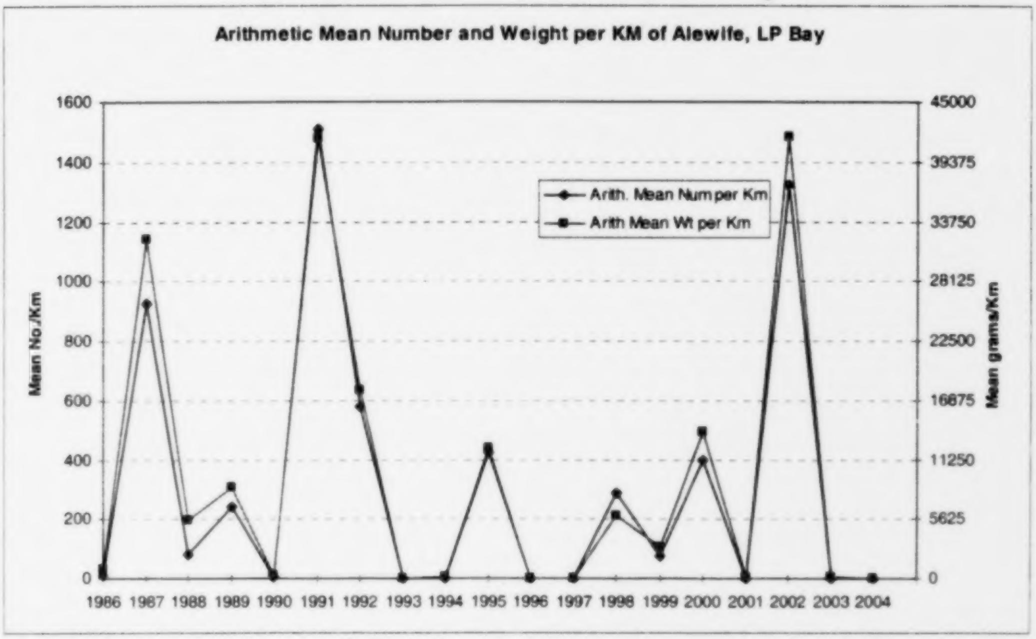


Figure 3.6-3. Variation in abundance of alewife in Long Point Bay from 1986-2004. Abundance was very low in 9 of 19 years, indicating major fluctuations in availablility of alewife as forage.

3.7 Burbot

Burbot were a significant part of the original cold-water fish community in eastern Lake Erie (Edwards and Ryder 1990). Burbot spawn during the winter in near shore areas under the ice (Scott and Crossman 1973). Fry hatch early after ice out and are initially pelagic. Juvenile burbot are found under rocks and in cover, in epilimnetic waters. Adults inhabit colder, hypolimnetic waters. Burbot are an ambush predator, as they wait in feeding channels on the bottom for unwary prey (Boyer *et al.* 1989). Underwater photography of ice scours in Lake Erie has documented the existence of holes or caves in the side of the scours, holding small burbot (Steve Blasco, Geological Survey Canada, Dartmouth, N.S., pers. comm.). Burbot have been tracked by telemetry in Lake Opeongo (Carl 1995). They remain in one place during the day, but at night travel a regular route around their territory, presumably feeding on fish and invertebrates. Burbot are an extremely important part of the deepwater food web, and they can capture large prey fish (e.g. yearling whitefish). Recently, round goby have become a significant item in the diet of burbot (Markham *et al.* 2004).

Burbot catches in the Partnership index fishing survey show a fairly even distribution across the eastern basin (Figure 3.7-1). This is consistent with a territorial, non-schooling species. There has been a strong trend of increasing catch of burbot during the 1990s (Figure 3.7-2, from Markham *et al.* 2004). Burbot are harvested as by-catch in commercial trawls and whitefish bottom-set gill nets. Trials with smelt trawls fitted with large square mesh cod-ends were effective at releasing small fish, and retaining whitefish along with a substantial burbot by-catch (Scantec Ltd. 1994). Lake trout were a very small by-catch. Commercial burbot harvests are not indicative of abundance, as most burbot are discarded.

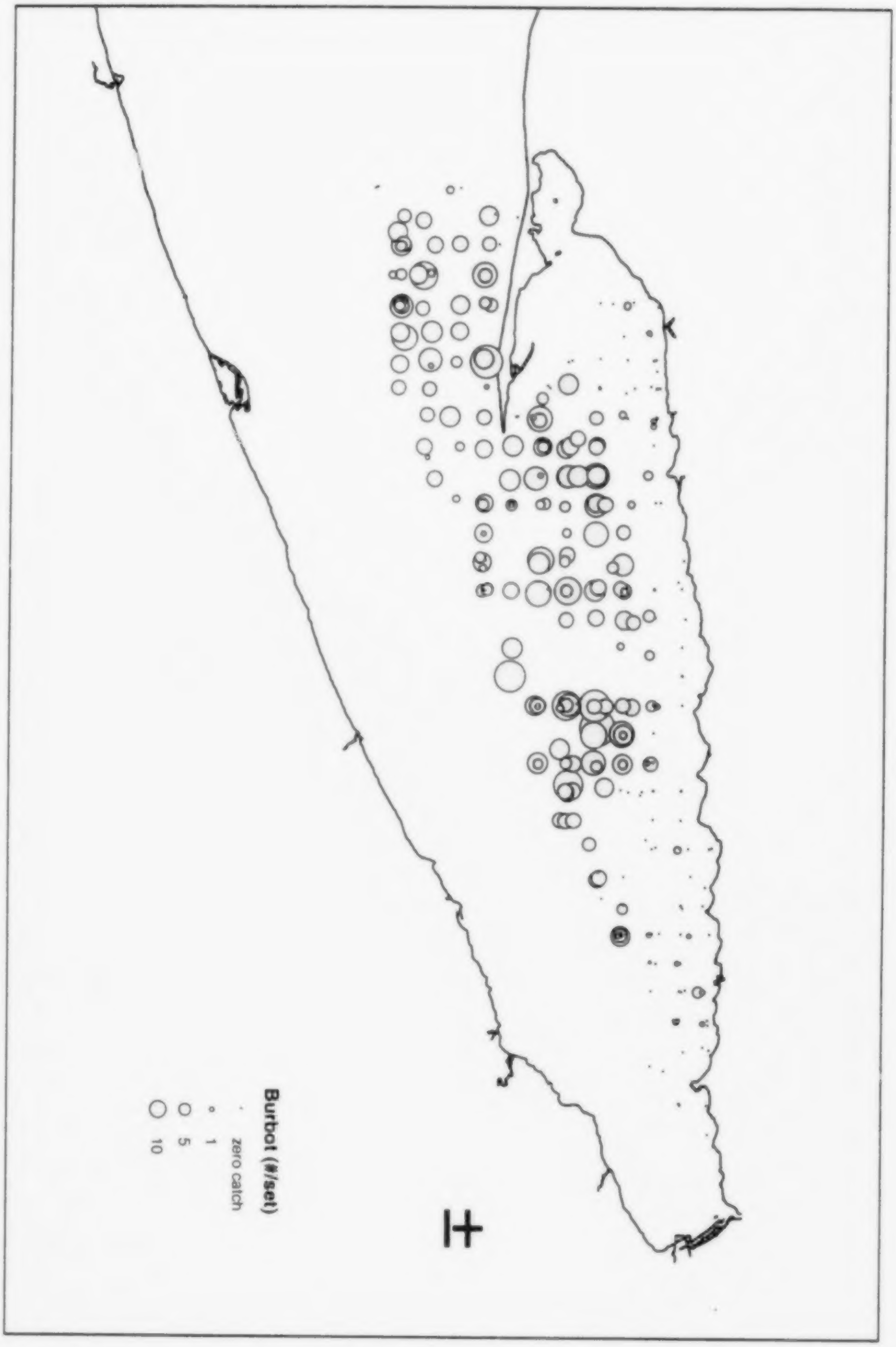

Burbot (#/set)
zero catch
1
5
10

Figure 3.7-1. Lake Erie, eastern basin gillnetting sites indicating catches of burbot from the OMNR/OCFA Partnership index gillnetting program, 1998-2004.

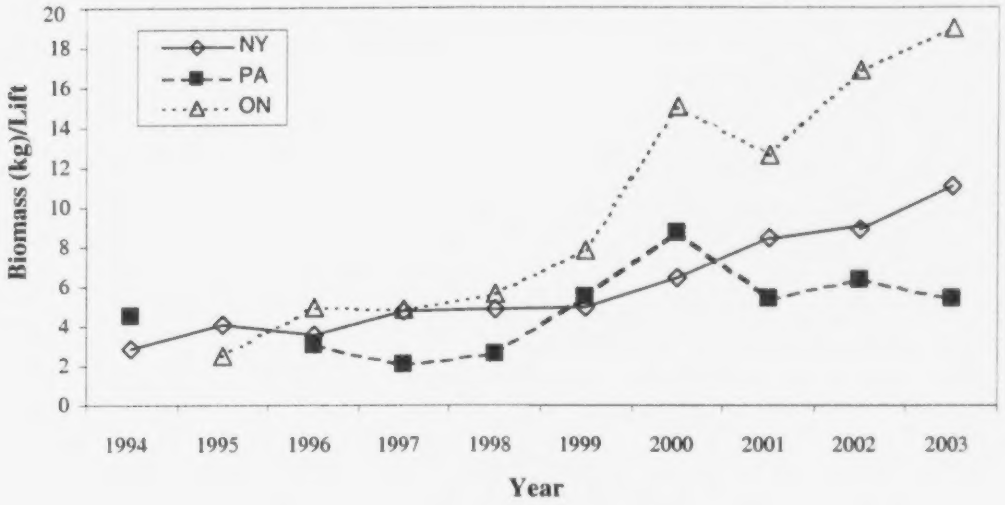


Figure 3.7-2. Average burbot biomass (kg/lift) from summer gill net assessment by jurisdiction, 1994-2003 (Markham *et al*. 2004).

3.8 Fish Biodiversity and Species at Risk

Lake Erie's eastern basin presently supports a diverse fish community. However, the component species and their relative abundances are different from what has existed historically. Since the establishment of native fish communities after the last ice age 10,000 years ago, changes in biodiversity have occurred both through losses and introductions. Changes in the relative abundance of individual species have occurred due to changing competitive interactions with new species, over-exploitation by man and habitat change over a variety of scales, from basin-wide trophic alterations to acute localized habitat loss.

Of the Great Lakes, Lake Erie has experienced the greatest number of introduced, non-native fish species. Of the 53 species introduced, 17 have become established (Cudmore-Vokey and Crossman 2000) and at least 14 of the 17 are residents of the eastern basin. Several have contributed to major changes in biodiversity and food web structure (Table 3.8-1). Niches once occupied by native lake trout (terminal predator), lake herring (pelagic planktivore), and whitefish and sturgeon (benthivores) are now filled by such exoticsas rainbow trout, rainbow smelt, gizzard shad and alewife. The round goby, first observed in the western basin of Lake Erie, has seen large increases within the eastern basin as shown using Long Point Bay trawling survey data (Figure 3.8-1). In addition to accidental or deliberate introductions of fish species to the lake, there has been an increase in the rate and degree of expansion of the ranges of invasive species now only found in the lake's US waters. Warmouth (*Chaenobryttus gulosus*), are present but not established in the north shores of Lake Erie and have recently been observed in Inner Long Point Bay (Mandrak, DFO, Burlington, ON, pers. comm.). Cudmore-Vokey and Crossman (2000) anticipate that the main cause of changes in biodiversity in the future will be introductions, citing estimates of 2-3 species introduced to Great Lakes watersheds each year.

Declines in aquatic habitat diversity lead to reductions in fish biodiversity through the loss of species which are adapted to narrow niches. Similarly, fragmentation of a habitat can result in isolated "islands" that are either too small to sustain sensitive species or confine species to remnant populations. Within Lake Erie, many aquatic habitat types have been severely reduced or lost either directly through development (e.g. shoreline armouring, backfilling, dredging, and damming) or indirectly through contamination (point source and non-point source) and biotic introductions. For example, declines in populations of lake sturgeon can be directly attributed to over-exploitation coupled with the damming of spawning rivers. Alteration of habitat by the invasive dreissenid mussel has intensified trophic changes occurring through human-influenced nutrient reductions (eutrophic - oligotrophic) but has also physically altered benthic habitat, extirpated important benthivore food sources and facilitated food web pathway changes by providing a food source for the invasive round goby.

Lake Erie has lost 10 native species (Table 3.8-1) and contains several which are considered threatened. A number of classification schemes are in place to categorize the degree to which species are threatened. Federally, the Species at Risk Act (SARA) recognizes the following categories: Special Concern, Threatened, Endangered, Extirpated, Extinct and Not Threatened. Several SARA species are known to exist within the eastern basin. The threatened spotted gar (*Lepisosteus oculatus*) inhabits marshes associated with Long Point and has been collected as recently as 2004 (Mandrak, DFO, Burlington, ON, pers. comm.). The endangered pugnose shiner (*Notropis anogenus*) also inhabits Inner Long Point Bay. The threatened lake chubsucker (*Erimyzon sucetta*) inhabits areas associated with Long Point and the Big Creek wetlands. Species such as the channel darter (*Percina copelandi*; threatened) and the silver chub (*Macrhybopsis storeriana*; special concern) were known to inhabit the nearshore off of Port Dover but have not been reported since 1946 and 2001, respectively, despite annual trawling surveys (1980-present). Recent electrofishing surveys within tributaries of the eastern basin have noted the presence of the threatened eastern sand darter (*Ammocrypta pellucida*) and an as yet unidentified species of Buffalo (*Ictiobus sp.*; likely a hybrid) in the lower Grand River. It should be noted that tributaries of Lake Erie are known refuges for native freshwater mussel species, many that are listed under SARA, that have been extirpated from the lake since the appearance of the invasive dreissenid mussel.

Some fish species are rare in Lake Erie, but their abundance elsewhere precludes them from provincial or federal listings. Lake sturgeon is an example of a once abundant contributor to the fish community of the eastern basin which now is rare due to over-exploitation in combination with introduced barriers to reproduction, in particular the damming of rivers used for spawning (e.g. Grand River). The lake herring once supported a strong fishery in Lake Erie and spawned in Long Point Bay. The species has been considered extirpated in Lake Erie, but the frequency of reports of herring in recent years indicate that there is potential for recovery.

Quantitative measures of fish communities, including species richness and relative abundance, can be used to rank the health of habitats using an index of biotic integrity (IBI) as proposed by Karr (1981). Attempts to develop a fish IBI for Lake Erie's eastern basin nearshore and tributary environments have been confounded by the number of species currently present and the fact that unstressed, pristine environments and the full range of native Lake Erie species with which to set the limits of the index no longer exists (Ohio EPA; Thoma 1999). Examination of fish species caught while electrofishing in the nearshore and lower tributaries of the eastern basin from 1999-2002 reveal low diversity despite some areas of high species richness. IBI scores (utilizing the EPA protocol developed for the western basin), generated from these catches resulted in habitat classifications ranging from "poor" to "fair" (Figure 3.8-2). Many of the lower scores can be attributed to low overall species richness and high abundances of non-native species. Species which are generalists with regard to habitat requirements tended to dominate the fish communities of the eastern basin nearshore and tributaries whereas species with more specialized requirements were rarer. Areas which scored the highest include Long Point in the west and the eastern sheltered embayments of Abino Bay and Gravely Bay (Port Colborne). All three locations are shallow, sheltered productive waters with abundant, diverse submerged macrophyte communities. As noted previously, the Long Point area provides habitat for several fish species that are considered rare or endangered.

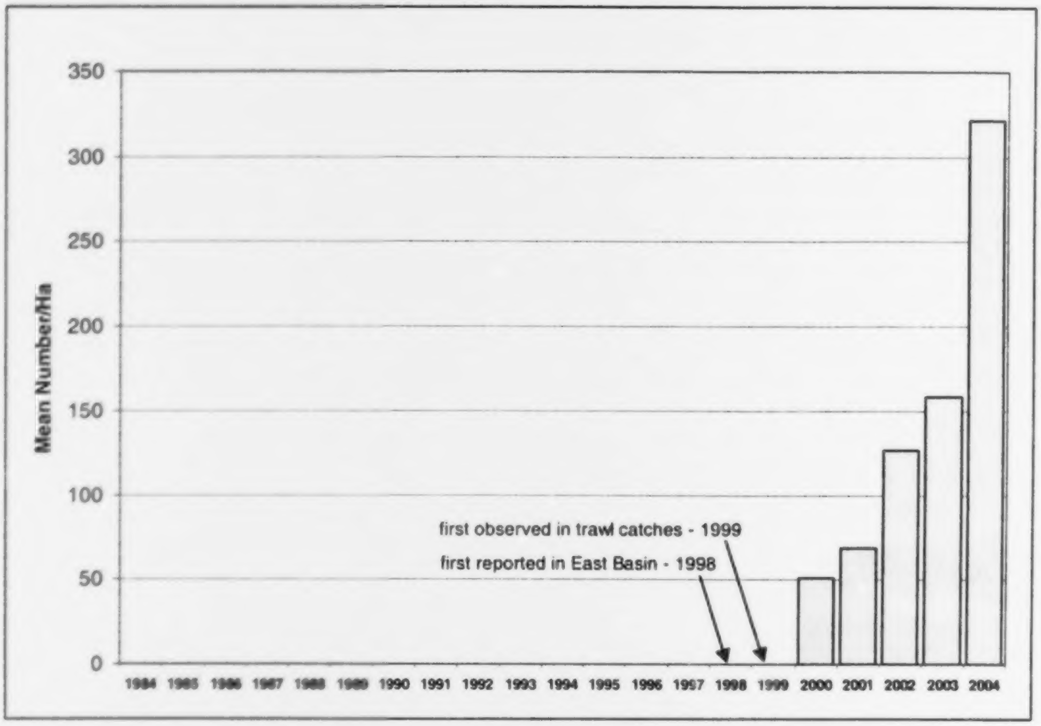


Figure 3.8-1. Relative abundance of round goby in OMNR Outer Long Point Bay Index Trawl catches, 1984-2004.

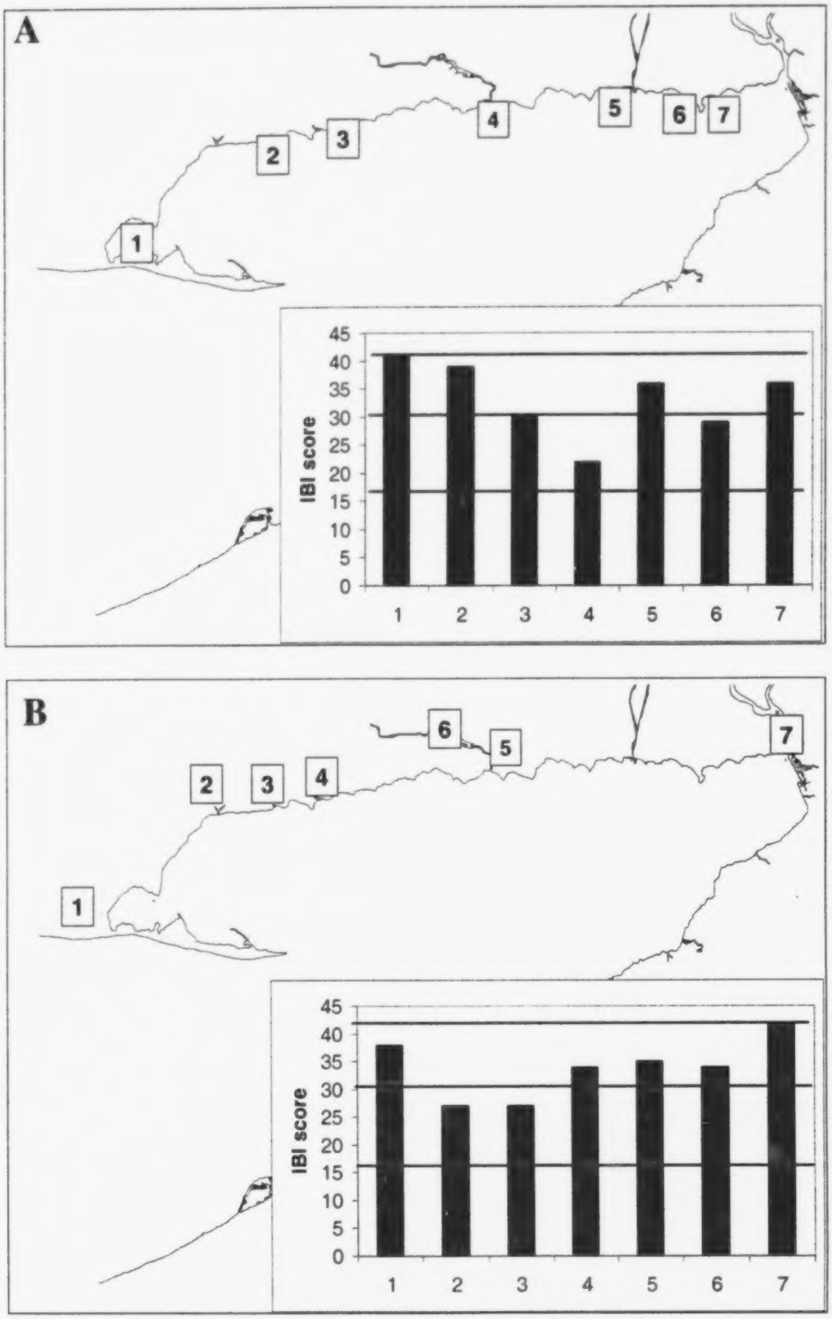


Figure 3.8-2. Index of Biotic integrity scores generated from fish gathered during eastern basin electrofishing 1999-2002 for A) nearshore and B) tributary sites. Integrity classifications as per Thoma (1999) as follows: exceptional (>50), good (>42), fair (>31), poor (>17), and very poor (<=17).

Table 3.8-1. Introduced and established fishes in eastern Lake Erie

Species Introduced and Established	
PETROMYZONIDAE	
Petromyzon marinus	sea lamprey
CLUPEIDAE	
Alosa pseudoharengus	alewife
Dorosoma cepedianum	gizzard shad
CYPRINIDAE	
Carassius auratus	goldfish
Cyprinus carpio	common carp
Scardinius erythrophthalmus	rudd
OSMERIDAE	
Osmerus mordax	rainbow smelt
SALMONIDAE	
Oncorhynchus gorbuscha	pink salmon
Oncorhynchus kisutch	coho salmon
Oncorhychus mykiss	rainbow trout
Oncorhynchus tshawytscha	chinook salmon
Salmo trutta	brown trout
MORONIDAE	
Morone americana	white perch
GOBIIDAE	
Neogobius melanostomus	round goby

Species Extirpated or Extinct	
CYPRINIDAE	
Notropis anogenus	pugnose shiner
Notropis heterodon	backchin shiner
Notropis heterolepis	blacknose shiner
SALMONIDAE	
Coregonus zenithicus	(shortjaw cisco)
Salvelinus namaycush	(lake trout original stock)
COTTIDAE	
Cottus cognatus	slimy sculpin
Cottus ricei	spoonhead sculpin
CENTRARCHIDAE	
Lepomis megalotis peltastes	longear sunfish
PERCIDAE	
Stizostedion canadense	sauger
Stizostedion vitreum glaucum	blue pike

4.0 Discussion

4.1 State of Fisheries

Walleye are shared between commercial and recreational fisheries. Walleye abundance was maintained in the easternWalleye cap area during the rehabilitation period under the reduced harvest strategy. The combination of the Walleye cap area and an adjacent more liberal harvest area in the western part of the management zone provides a way to direct most of the fishing effort into an area where stocks (eastern basin, western basin origin) are likely to be mixed. The Partnership index gillnetting survey and the angler diary program provide ways to monitor trends in the abundance of walleye and fishing quality, respectively.

The Grand River walleye stock has contributed to the east basin fishery as large fish, but interestingly did not contribute much to the catch of age 1 walleye in index nets set in Long Point Bay in 2004. It is possible that walleye do not leave the river to any great extent until they reach age two or three, and favour cooler temperatures as maturing fish. The location of the western boundary of the Walleye cap area was linked to the expected distribution of young fish coming out of the Grand River. No gill net areas nearshore in the Niagara cap area and in the Dover area serve to provide protection to young walleye as well as yellow perch from the small mesh commercial fishery.

Several different scenarios for the future of the walleye population in eastern Lake Erie and apparent management classes are:

1. "Stocks in Rehabilitation" – our current situation has the overall abundance below the 2000 level. We need to recognize the reduced population size by continued conservation measures. Both eastern and western basin stocks are at relatively low abundance, insofar as they contribute to fisheries in the eastern basin. This status may improve as the strong 2003 year class matures and becomes more broadly distributed throughout the lake. Continued conservation management may be beneficial.

2. "Eastern Stocks Healthy" – fish abundance can support increased allocations to Niagara area commercial fish licences and a stronger recreational fishery.

3. "Eastern and Western Stocks Healthy" – fish abundance can support increased allocations to Niagara area commercial licences and to the Dover area, as well as a stronger recreational fishery.

The NYDEC have demonstrated by otolith aging that the eastern Lake Erie walleye stocks have great longevity. The history of irregular recruitment in the eastern basin stocks means that management actions should work to toward sustainable harvest over a number of years, including years of poor recruitment. One method to maintain sustainable fisheries is to employ relatively low fishing mortality.

Yellow perch is another species that is shared between recreational and commercial fisheries. The protection strategies for smallmouth bass have also established inshore refuges for yellow perch. In the Nanticoke area, these areas provide an extremely high quality recreational fishery for yellow perch as well as smallmouth bass.

Currently, yellow perch abundance is high across the entire east basin. The yellow perch commercial fishery, on the other hand, varies from very strong in the Dover area and the offshore areas of the far east to poor in the nearshore areas of the far east. One explanation may be that the far eastern zone is a "spill-over" zone for yellow perch from all sources in the east. Genetic analysis currently in progress may help to clarify this (Carol Stepien, in progress). For example, if the 1998 year class, which shows strongly in the index nets in the eastern part of the management zone, originated in Long Point Bay, it would indicate that the fish from strong year classes disperse farther than described during the Nanticoke study. The limited abundance of yellow perch nearshore may be due to limited recruitment in that area, which is consistent with limited spawning and nursery habitat. Commercial fishers should be able to target perch offshore without conflict with anglers.

The mapping of the yellow perch distribution (figure 3.2-2) showed comparatively few fish south of Long Point. The location of the western boundary of the Eastern Basin Management Zone may need to be considered in this regard.

It would be useful to determine a fishing policy for yellow perch in the eastern zone based on Partnership index fishing data due to the difficulty in ensuring adequate sampling of small fisheries. Such an approach could incorporate abundance (CPUE), mean age, the Abrosov model (# opportunities to spawn before harvest), target fishing mortality and/or fishing quality, and an analysis of uncertainty in stock status and the risk associated with various fishing rates. In the longer term, a program to collaborate with the NYDEC on a perch population analysis for this area should be explored.

Smallmouth bass is a recreational fish species. A series of closed areas restricting commercial fishing now prevents significant by-catch in the yellow perch commercial fishery. Similarly, a series of sanctuaries (closed to both recreational and commercial fishing) have protected spawning bass in the spring (figure 3.1-1). These factors have contributed to a very strong smallmouth bass recreational fishery in the eastern basin of Lake Erie.

Smallmouth bass were found in large numbers nearshore in the spring during a survey to locate concentrations of spawning walleye east of the Grand River. They are capable of predation on relatively large fish and biologists suspect that their abundance nearshore could influence yellow perch and walleye recruitment. Smallmouth bass are well utilized in the recreational fishery in the western area of the east basin, and could likely support more fishing in the far east.

These three species represent the most significant fisheries in the eastern basin under current conditions. These species are embedded within a larger aquatic community and interact with other species through predation and competition. For example, walleye depend on smelt as a primary forage species. Does the current fishery for smelt constrain the population size for species that use it for forage (walleye, lake trout, burbot, rainbow trout)? Bioenergetic analysis of what it takes to feed these predator populations is an important exercise in understanding these issues (Einhouse *et al.* 1993, 1999). A community model (Lake Erie Ecological Model) developed at Case Western Reserve University (Koonce *et al.* 1999) provides a framework to address these questions.

4.2 State of Habitat Discussion

Nearshore and Tributary habitat

The lower reaches of eastern basin tributaries and six key areas of nearshore/sheltered embayment - Abino Bay, Gravelly Bay, Port Maitland, Peacock Point (Nanticoke), Sandusk nearshore, and Inner Long Point Bay- were surveyed by night-time boat electrofishing. The primary goal of the surveys was to assess use of these areas by yellow perch and walleye, especially with regard to their potential as nursery habitat for young-of-the-year (YOY) and juvenile fish. Additionally, the fish community as a whole was used as an indicator of relative habitat health based on the Index of Biotic Integrity (IBI), first proposed by Karr (1981) and modified by the Ohio Environmental Protection Agency (Thoma 1999) to be relevant to nearshore and lake effected lower tributary areas of Lake Erie (Figure 3.8-2).

Relative catches of yellow perch from 1999-2003 suggested obvious and repeatable differences between areas as outlined in Section 3.2 and Figure 3.2-1. Juvenile yellow perch were most abundant in warm, shallow, sheltered embayments with clear waters, and high densities of submerged macrophytes. Areas fitting this description are not the norm for the north shore of the eastern basin; most nearshore areas are high energy zones exposed to prevailing onshore winds. High density juvenile yellow perch areas include Inner Long Point Bay, Outer Long Point Bay, Gravelly Bay (Port Colborne), Abino Bay and some sheltered areas of the upper Niagara River. Juvenile yellow perch were relatively scarce in lower tributary mouths and noticeably rare in the lower sections and wetlands of the Grand River, which historically supported this species. The habitat attributes of poor water clarity, high suspended solid loads and scarcity of submerged macrophytes were the obvious differences between the tributary areas and those areas that displayed higher perch abundance.

In contrast to the yellow perch distributions, juvenile walleye were scarce in electrofishing catches from the eastern basin nearshore. While a small number were found in the nearshore around Point Abino, the only consistent nearshore source of walleye was in the vicinity of the Grand River. As walleye utilized the Grand River throughout the year, the demographics of the catch changed seasonally to reflect the aggregation of larger/older fish which move out of the river in the late spring and return in the early to late fall. YOY walleye were only found within the Grand River. Despite records of historic spawning runs of walleye in Big Creek, there is no evidence that this has occurred in recent years.

The IBI scores generated from fish community catches (Figure 3.8-2) range from "poor" to "fair". These scores generally confirm conclusions generated by the Lake Erie LaMP beneficial use impairment exercise which deemed fish habitat in Lake Erie tributaries (including riverine estuaries) and coastal wetlands to be impaired. The higher IBI scores corresponded with areas of high yellow perch production and with areas that harbour the small numbers of species at risk that exist within the eastern basin.

Further detailed habitat investigations were conducted within the lower Grand River in order to assess the impairment that presently precludes its use by juvenile yellow perch and presumably as a yellow perch spawning area. The water quality within the lower Grand River was found to be degraded. During the summer it is typically high in nutrients and suspended solids; levels of total phosphorus and nitrates frequently exceed provincial water quality objectives. Corresponding high suspended algal production combined with high suspended solid loads generate conditions that are unfavourable for submerged macrophytes. Temperature and oxygen depth profiles indicate that the potential exists, particularly under low flow conditions, for most fish to be excluded from much of the lower river habitat due to low oxygen and high (lethal) temperature conditions. Benthic invertebrate surveys similarly point to eutrophic and compromised habitat in the lower Grand and corroborated Lake Erie river mouth sampling done by the Ministry of the Environment in 1998 (MOE 2004).

Large efforts to modify land-use practices within the Grand River watershed will be necessary in order to create an environment in the lake effect zone that will once again support spawning and/or nursery use by yellow perch. After three years of monitoring, it is apparent that habitat in the Grand River upstream of Dunnville varies in quality with flow from reservoirs, underlying the significance of baseflow interacting with nutrient levels. Some conditions observed were adverse to fish and indicated the likelihood for more severe conditions. Currently, the Dunnville dam presents a barrier that is undoubtedly limiting the Grand River stock of walleye from reaching its productive potential. Increased electrofishing catches of YOY walleye in recent years suggest that the manual transfer of migrating adult walleye over the barrier (conducted in 2000-2004) has supplemented the ability of the Dunnville fishway to pass walleye. Recent radio telemetry surveys and past habitat mapping show the potential for successful walleye spawning to occur in the river below the dam is very limited. Currently, more walleye stage below the dam than are able to access spawning habitat from York to Caledonia.

Nearshore habitat conducive to yellow perch production within the eastern basin should be recognized and encroachments on these areas should be avoided. Active work toward improving water quality within tributaries flowing into the basin will increase the ability of these areas to support yellow perch but must be conducted with the understanding that without concurrently addressing the disruptive behaviour of exotic fish species (esp. common carp) and the past large scale alteration of river mouths, deltas and wetlands, full restoration is unlikely.

The Dunnville dam presents a bottleneck to production of the Grand River walleye stock, which needs to be resolved in order to recognize the potential of the Grand River stock.

5.0 The Policy Perspective on Management

5.1 Lake Erie Management Unit

Earlier in the report, the transition between management delivered by the district offices to management delivered by the Lake Erie Management Unit (LEMU) was described. The inside page of the report cover provides a history of the LEMU and describes its vision, mission and goal (Lake Erie Management Unit 2001).

An extensive public consultation has led to development of the Strategic Plan for Ontario Fisheries (OMNR 1992). Table 5.1-1 summarizes the plan, and should guide discussions regarding fisheries management in eastern Lake Erie.

Table 5.1-1. The strategic plan for Ontario fisheries (OMNR 1992).

Goal:	Healthy aquatic ecosystems that provide sustainable benefits, contributing to society's present and future requirements for a high-quality environment, wholesome food, employment and income, recreational activity, and cultural heritage.
Objectives:	1. to protect healthy aquatic ecosystems; 2. to rehabilitate degraded aquatic ecosystems; and 3. to improve cultural, social and economic benefits from Ontario's fisheries resource.
Guiding Principals:	1. Sustainable development - Sustainable development requires that adverse impacts on natural elements such as air, land and water, be minimized to ensure the aquatic ecosystem's overall integrity. 2. Limit to resource - There is a limit to the natural productive capacity of aquatic ecosystems and, hence, a limit to the amount of fish that can be harvested from them. 3. Natural reproduction - Naturally reproducing fish communities, based on native fish populations, provide predictable and sustainable benefits with minimal long-term cost to society. 4. Knowledge - Good fisheries management is scientifically based and relies on the acquisition and use of the best available knowledge. 5. Social benefits - Resource management decisions, including allocation, shall be based on ecological, social, cultural and economic benefits and costs to society, both present and future.
Strategic Management Actions:	1. Ensure benefits are sustained by protecting and rehabilitating aquatic ecosystems 2. Inform and involve the public in decision making and program delivery to foster stewardship 3. Ensure resources are appropriately valued 4. Ensure effective program management and co-ordination among agencies 5. Acquire and communicate essential knowledge for timely and effective resource management decision-making 6. Enforce firmly and effectively

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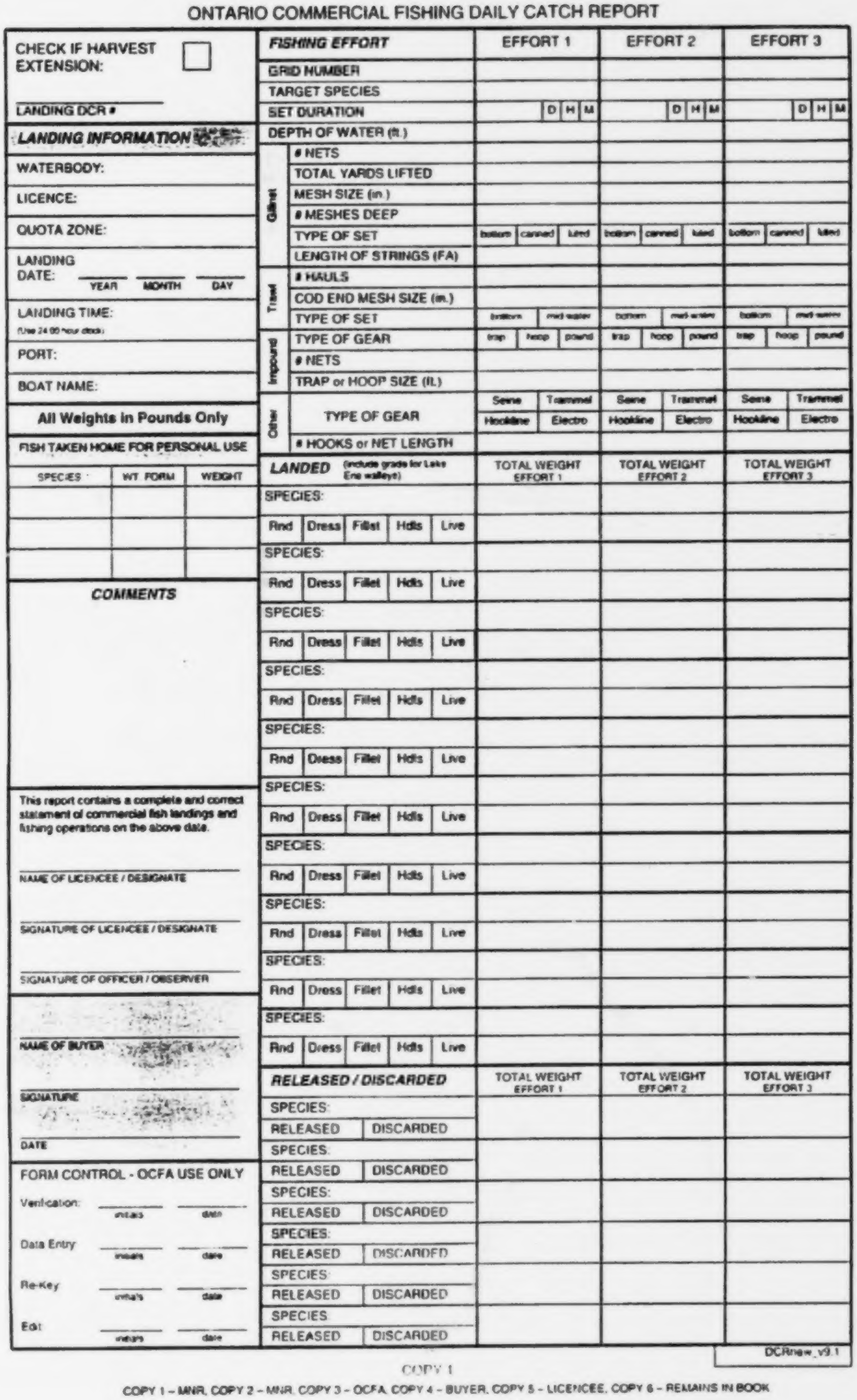
Appendices

Appendix 1. Daily Catch Report form.



ONTARIO COMMERCIAL FISHING DAILY CATCH REPORT

CHECK IF HARVEST EXTENSION: ☐

LANDING DCR #

LANDING INFORMATION

WATERBODY:

LICENCE:

QUOTA ZONE:

LANDING DATE: YEAR MONTH DAY

LANDING TIME: (Use 24:00 hour clock)

PORT:

BOAT NAME:

All Weights in Pounds Only

FISH TAKEN HOME FOR PERSONAL USE

SPECIES	WT. FORM	WEIGHT

COMMENTS

This report contains a complete and correct statement of commercial fish landings and fishing operations on the above date.

NAME OF LICENCEE / DESIGNATE

SIGNATURE OF LICENCEE / DESIGNATE

SIGNATURE OF OFFICER / OBSERVER

NAME OF BUYER

SIGNATURE

DATE

FORM CONTROL - OCFA USE ONLY

Verification: initials date

Data Entry initials date

Re-Key initials date

Edit initials date

	FISHING EFFORT	EFFORT 1	EFFORT 2	EFFORT 3
	GRID NUMBER			
	TARGET SPECIES			
	SET DURATION	D H M	D H M	D H M
	DEPTH OF WATER (ft.)			
Gillnet	# NETS			
	TOTAL YARDS LIFTED			
	MESH SIZE (in.)			
	# MESHES DEEP			
	TYPE OF SET	bottom canned kited	bottom canned kited	bottom canned kited
	LENGTH OF STRINGS (FA)			
Trawl	# HAULS			
	COD END MESH SIZE (in.)			
	TYPE OF SET	bottom mid-water	bottom mid-water	bottom mid-water
Impound	TYPE OF GEAR	trap hoop pound	trap hoop pound	trap hoop pound
	# NETS			
	TRAP or HOOP SIZE (ft.)			
Other	TYPE OF GEAR	Seine Trammel Hookline Electro	Seine Trammel Hookline Electro	Seine Trammel Hookline Electro
	# HOOKS or NET LENGTH			

LANDED (include grade for Lake Erie walleye)	TOTAL WEIGHT EFFORT 1	TOTAL WEIGHT EFFORT 2	TOTAL WEIGHT EFFORT 3
SPECIES:			
Rnd Dress Fillet Hdls Live			
SPECIES:			
Rnd Dress Fillet Hdls Live			
SPECIES:			
Rnd Dress Fillet Hdls Live			
SPECIES:			
Rnd Dress Fillet Hdls Live			
SPECIES:			
Rnd Dress Fillet Hdls Live			
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SPECIES:			
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SPECIES:			
Rnd Dress Fillet Hdls Live			
SPECIES:			
Rnd Dress Fillet Hdls Live			
SPECIES:			
Rnd Dress Fillet Hdls Live			

RELEASED / DISCARDED	TOTAL WEIGHT EFFORT 1	TOTAL WEIGHT EFFORT 2	TOTAL WEIGHT EFFORT 3
SPECIES: RELEASED DISCARDED			
SPECIES: RELEASED DISCARDED			
SPECIES: RELEASED DISCARDED			
SPECIES: RELEASED DISCARDED			
SPECIES: RELEASED DISCARDED			
SPECIES: RELEASED DISCARDED			

DCRnew_v9.1

COPY 1

COPY 1 – MNR, COPY 2 – MNR, COPY 3 – OCFA, COPY 4 – BUYER, COPY 5 – LICENCEE, COPY 6 – REMAINS IN BOOK

Appendix 2

Public Consultation Regarding Fisheries Management in Eastern Lake Erie

T. Werner
Lake Erie Management Unit
Box 429
Port Dover ON N0A 1N0

Background

On February 15, 16 and 22 of 2005, the Ministry of Natural Resources held Open Houses in Port Colborne, Dunnville and Simcoe respectively. Information about the state of the walleye and yellow perch fisheries in eastern Lake Erie was presented in poster form. A series of management alternatives implemented under the "Five Year Plan for Rehabilitation" 2000-2004 were presented for comment. The alternatives were developed through an earlier consultation with commercial and recreational fishery stake holders. Strategies addressing the location of the western boundary to the zone, walleye and yellow perch fishery management, and management of Long Point Bay were included in a questionnaire and presented to interest groups to seek public input. In total 115 multiple choice questionnaires (Port Colborne 41, Dunnville 21, and Simcoe 53) were completed and results and comments are summarized below.

Eastern Basin Management Zone Boundary

The questionnaire (Appendix A) started with the specific question of where to place a boundary for the Eastern Basin Management Zone (Figure 1). A total of 55% were in favour of keeping the same boundary used during the rehabilitation plan period (2000-2004) and 38% felt it should be moved further east to the tip of Long Point. Of the remaining 7%, suggestions for boundary destinations were either further east or further west (Figure 2).

Management of Walleye (Figure 3)

When presented with the decision of keeping the current location (2000-2004) of the walleye cap area boundary or indicating another, 73% felt that keeping it was the right choice. Of the comments recorded, a great number of the remaining 27% suggested to make it a larger area and move it further west. A few recommended moving it east as they felt a smaller area would be more manageable.

Four choices were offered concerning the regulation of the walleye harvest in the western part of the East Basin Management Zone. A total of 8% felt that no regulation was needed at all, 18% opted to have harvest regulated in the western part of the zone, 15% thought that the harvest should be regulated or restrict the fishery only within Long Point Bay, and the majority (60%) suggest a combination of latter two.

When presented with the information that the fishery in the walleye cap area included a large percentage of fish from eastern spawning stocks; just over half (56%) indicated that the allocation of harvest in the cap area be should maintained at 32,000 lbs (2000-2004). The majority of the remaining 44% felt that the quota should be lowered to a level of somewhere between 16,000-29,000 lbs.

In response to the question: if the western walleye stocks were to increase in abundance and move eastwards, should the harvest from the cap area be increased, an 82% majority decided that harvest should not increase and suggested stocks need to rebuild.

Four alternatives were presented on the reduction of overlap of fishing activity between recreational and commercial fisheries inside Long Point Bay (inside line between tip of Long Point and Peacock Point). Just over half (51%) chose to establish licence conditions that prevent walleye fishing with canned nets from June to August inclusive, 30% chose the option of limiting harvest of walleye by commercial fishing during summer with low quota, 10% felt there was no need to address the overlap and most of the remaining 9% commented that commercial or canned netting should not be allowed inside Long Point Bay.

The next question was similar to the previous one, but addressed the overlap of commercial and recreational fisheries in the walleye cap area. The results were quite similar for 3 of the alternative options; 39% chose to establish an area of net free waters in the extreme eastern part of walleye cap area, 27% opted to maintain the gentlemen's agreement concerning canned net fishing on weekends and during tournaments and 21% felt that in order to do this, licence conditions must be established. A very small percent felt that the overlap did not need to be addressed and most of the remaining 8% suggested establishing licence conditions only if the gentlemen's agreement failed. A few other comments were recorded suggesting the elimination of commercial fishing in the EBMZ.

It was noted that harvest of small walleye from a stock that is being rehabilitated in the Grand River is viewed as a conservation issue by recreational and commercial fishing interests. Alternatives were offered on minimizing the harvest of small walleye downstream of Dunnville. A majority (60%) indicated setting a size limit on walleye as their number one preference. Restrictions on fishing near the dam held 18% of the vote, 12% felt that closing the season in winter would minimize the harvest and 5% chose the option to provide signs with the conservation message (in progress). Proposed size limits of anywhere between 14"-22" minimums were suggested by the larger majority.

Management of Yellow Perch (Figure 4)

The public was asked how the OMNR should manage yellow perch fisheries within the East Basin Management Zone. Almost half (43%) felt it should be managed as 2 areas, using the walleye cap area to separate areas for different management policy. Another 32% thought it should be managed as one area except for a cap area (limiting commercial harvest/and or other fishery restrictions) in the waters of Long Point Bay, 11% chose the option of having 2 areas of management with an alternative boundary and 10% thought it should be managed as one unit with no internal division.

Over half (57%) of those questioned thought the OMNR should establish a harvest policy for yellow perch that will optimize stability of fish supply, fishing success and fish size by limits on exploitation rate and mesh size. Another 18% chose the use of gear restrictions (mesh size) to promote a high quality yellow perch fishery in Long Point Bay; and 17% selected the option to obtain a close to maximum harvest in any given year, but would incur risk of maximizing variation in supply of fish from year to year.

Management of Long Point Bay Area (Figure 5)

The public were asked which fisheries should be optimized by OMNR management. Sixty-four percent suggested that recreational fishery management should be optimized. A very small number (5%) preferred to optimize management of the commercial fishery, and 30% proposed to manage both.

The management alternatives questionnaire was also distributed to commercial fishers at a Commercial Outreach Meeting on February 23, 2005. The result summaries were not included in the context of this report, but may be viewed in Appendix 2-B.

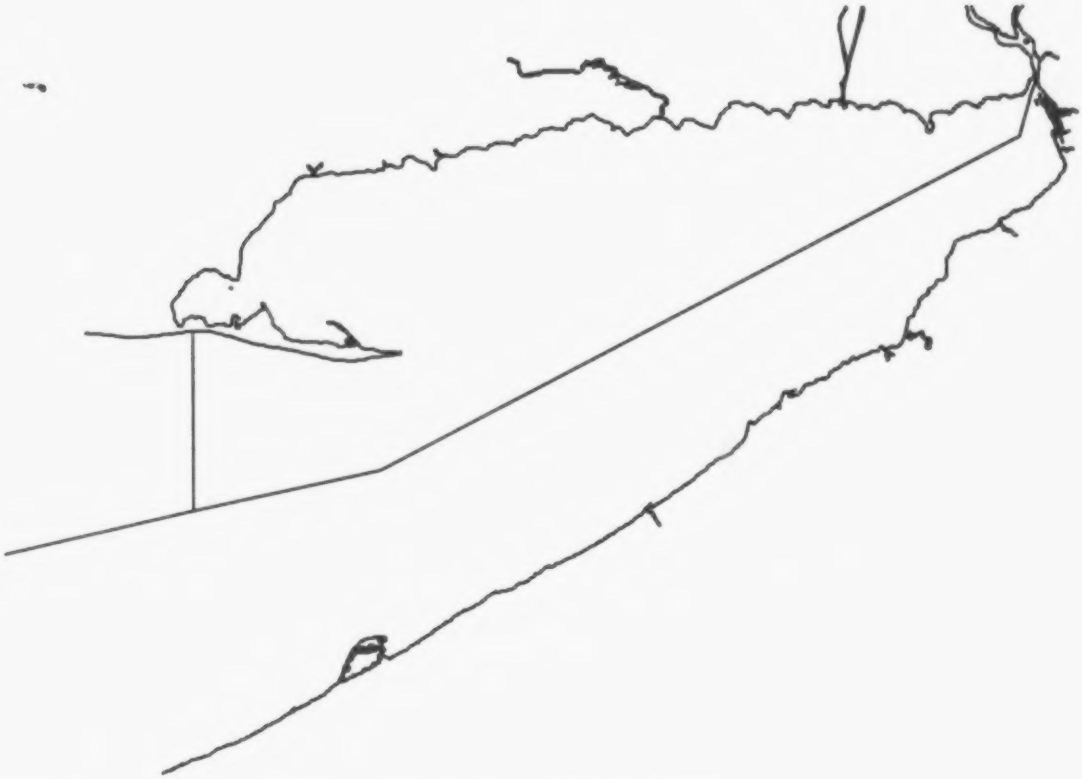


Figure 1. The east basin rehabilitation zone (2000-2004).

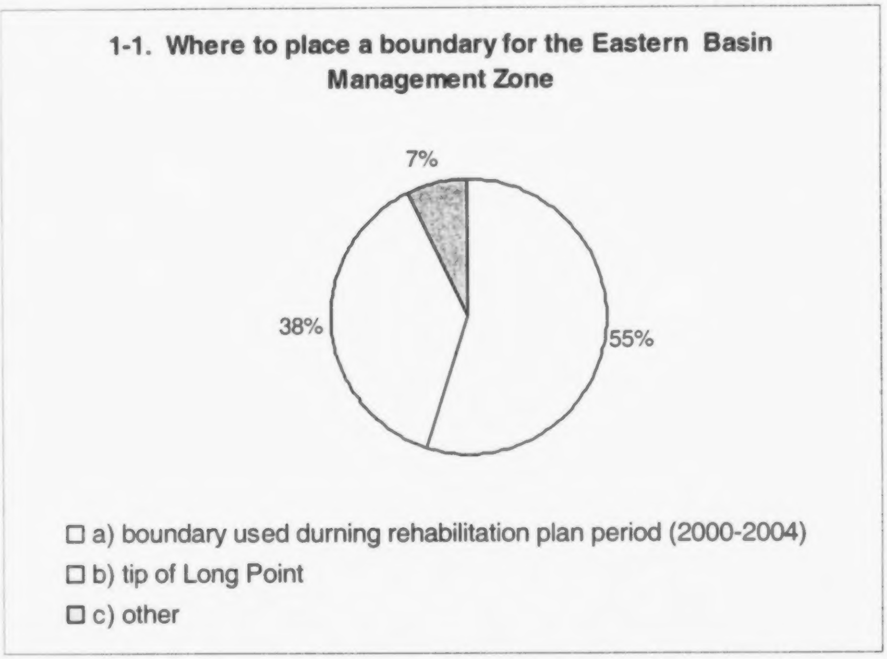
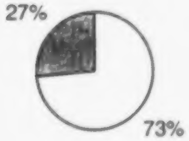


Figure 2. Results of preferred location of eastern basin management zone boundary (Q 1-1)

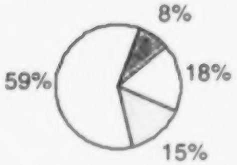
2-1. Location of boundary of walleye cap area:

☐ a) current location (2000-2004)
☐ b) other



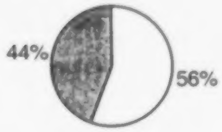
2-2. Regulation of walleye harvest in western part of the zone:

☐ a) no regulation
☐ b) regulate harvest in western part of zone
☐ c) regulate harvest or restrict fishery only within LPB
☐ d) regulate fishery following b) & c)



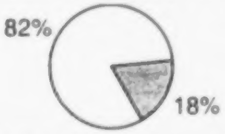
2-3. Allocations of harvest in the cap area should be maintained at:

☐ a) 32,000 lbs (2000-2004)
☐ b) set an alternative harvest level



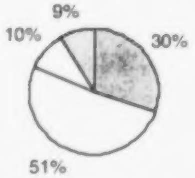
2-4. If western walleye stocks increase and move eastwards, should harvest from cap area be increased?

☐ a) no
☐ b) yes



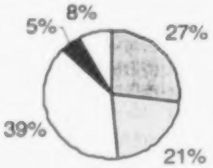
2-5. Overlap of fishing activity between recreational and commercial fisheries should be reduced inside LPB by:

☐ a) limiting harvest of walleye by commercial fishing in LPB during summer by low quota
☐ b) establishing licence conditions that prevent walleye fishing with canned nets from Jun to Aug inclusive
☐ c) overlap does not need to be addressed
☐ d) other



2-6. Overlap between recreational and commercial fisheries inside walleye cap area should be addressed by:

☐ a) maintaining gentlemen's agreement concerning canned net fishing on weekends and during tournaments
☐ b) establishing licence conditions to do this
☐ c) establishing an area of net free waters in extreme eastern part of the walleye cap area
■ d) overlap does not need to be addressed
☐ e) other



2-7. Harvest of small walleye downstream of Dunnville should be minimized by:

☐ a) providing signs that provide the conservation message (in progress)
☐ b) closed season in winter
☐ c) restrictions on fishing near the dam
☐ d) size limit on walleye
■ e) does not need regulation
☐ f) other

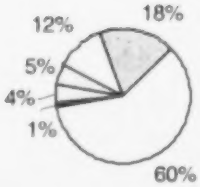
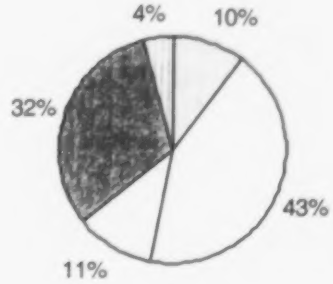


Figure 3. Results of preferred strategies for walleye management (Q 2)

3-1. OMNR should manage yellow perch fisheries:



☐ a) as one unit, with no internal division

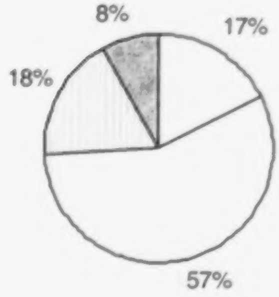
☐ b) as 2 areas, using the walleye cap area to separate areas for different management policy

☐ c) as 2 areas with an alternative boundary

☐ d) as 1 area except for cap area (limiting commercial harvest and/or other fishery restrictions) in LPB

☐ e) other

3-2. OMNR should establish a harvest policy for yellow perch that will:



☐ a) obtain close to maximum harvest, but incurs risk of maximizing variation in supply from year to yea

☐ b) optimize stability of supply, success and size by limits on exploitation rate and mesh size

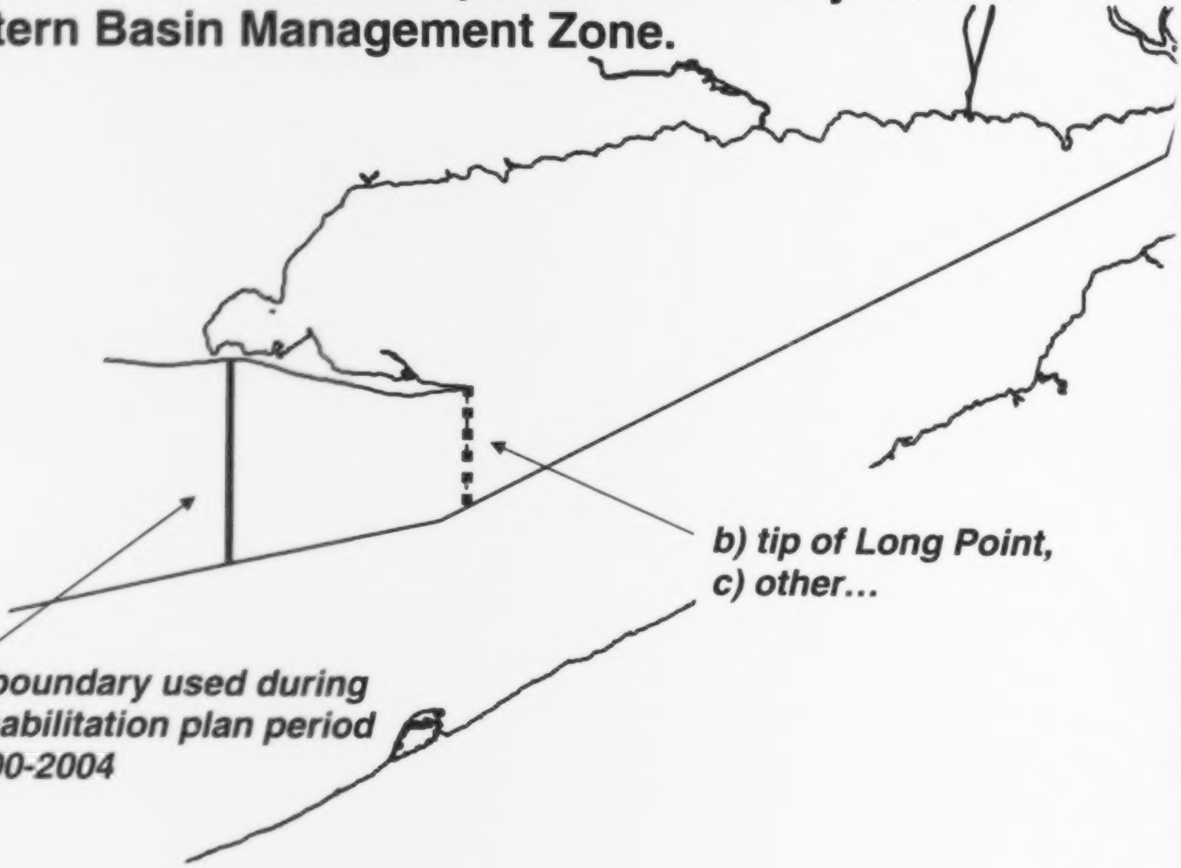
☐ c) use gear restrictions (mesh size) that promote a high quality yellow perch fishery in LPB

☐ d) other

Figure 4. Results of preferred strategies for yellow perch management (Q 3).

Appendix 7-A. East basin management alternatives questionnaire.

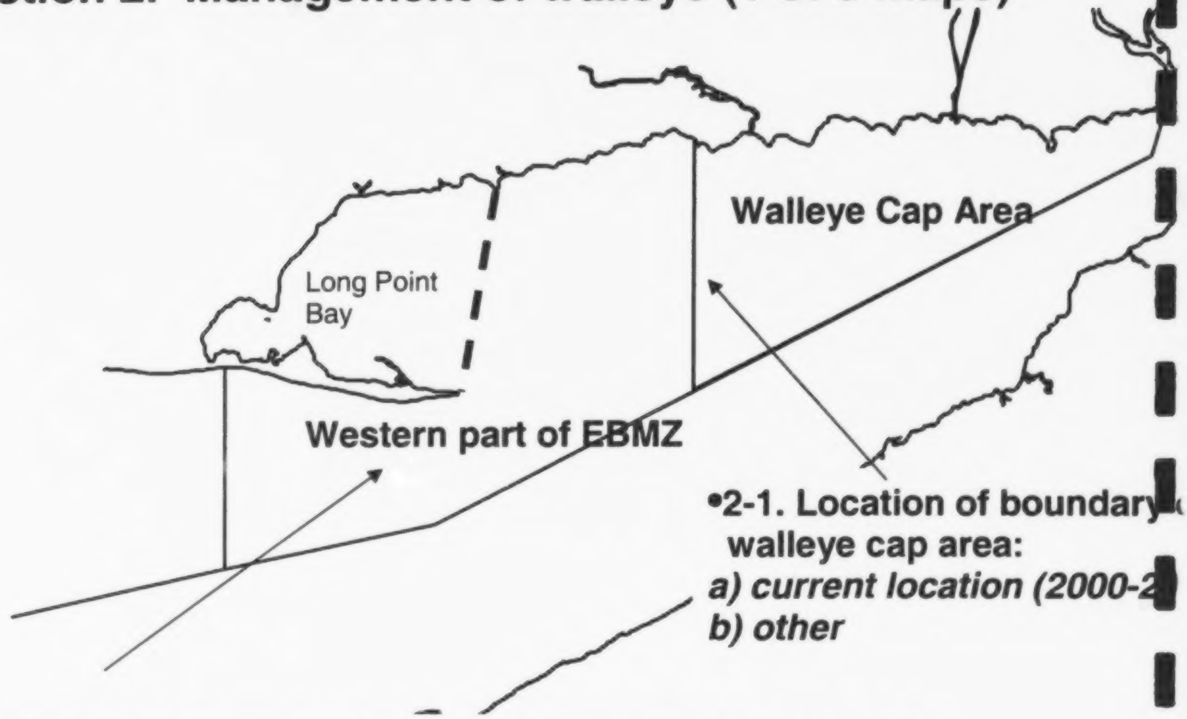
Question 1-1. Where to place a boundary for the Eastern Basin Management Zone.



b) tip of Long Point,
c) other...

a) boundary used during rehabilitation plan period 2000-2004

Question 2. Management of walleye (1 of 5 maps)


Walleye Cap Area
Long Point Bay
Western part of EBMZ

•2-1. Location of boundary
walleye cap area:

a) current location (2000-2

b) other

2-2. Regulation of walleye harvest in western part of the zone

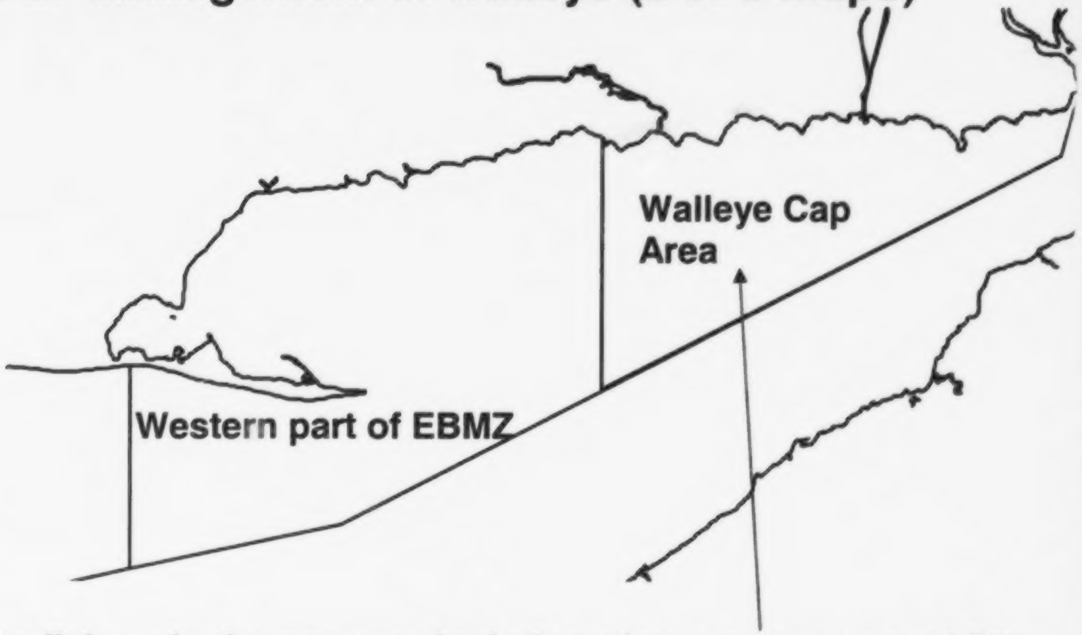
a) No regulation - fishery is seamless with rest of QA3.

b) Regulate harvest in western part of zone

c) Regulate harvest or restrict fishery only within Long Point Bay (see 2-5

d) Regulate fishery following both b) and c)

Question 2. Management of walleye (2 of 5 maps)



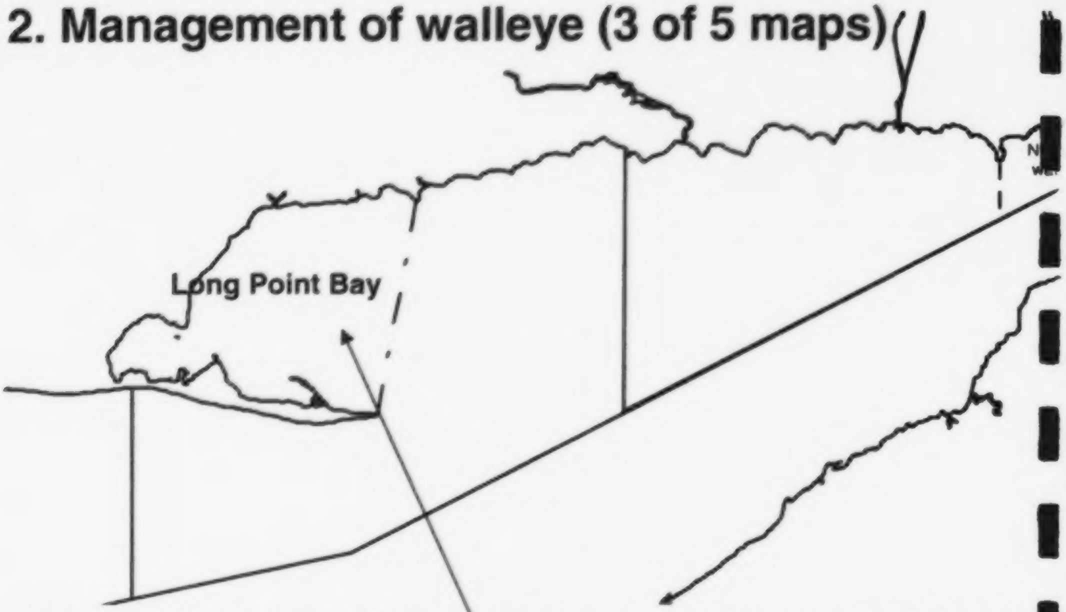
2-3. The fishery in the cap area includes a large percentage of fish from eastern spawning stocks. Should the allocation of harvest i the cap area be maintained at *a) 32,000 lbs (2000-2004), or b) set an alternative harvest level................*

2-4. If the western walleye stocks increase in abundance and move eastwards, should the harvest from the cap area be increased?

a) No and comment........................

b) Yes and recommendation.............

Question 2. Management of walleye (3 of 5 maps)



2-5. Overlap of fishing activity between sport and commercial fisher should be reduced inside Long Point Bay (inside line between tip Point and Peacock Point)

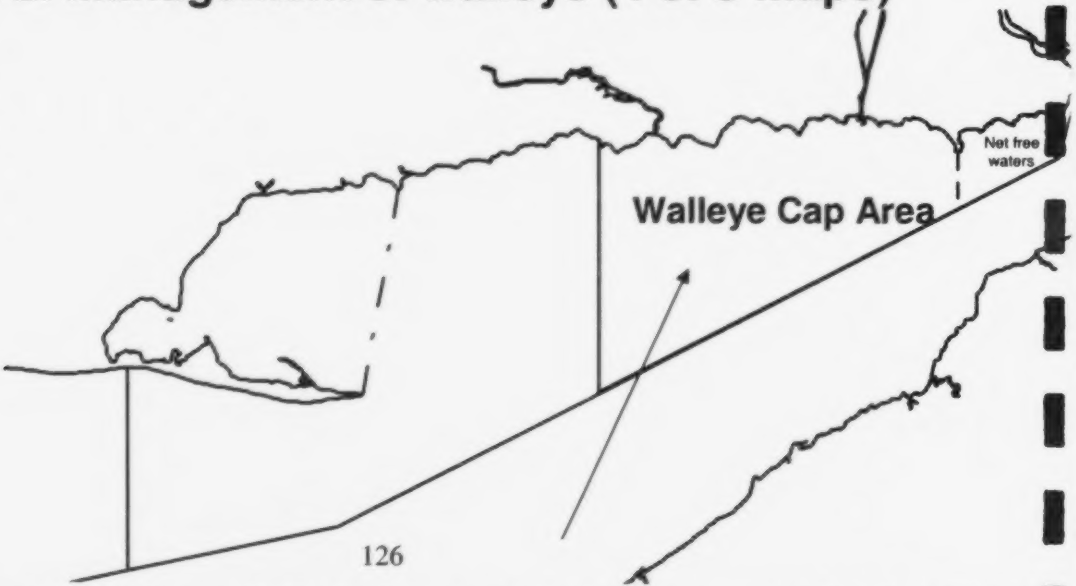
a) limiting harvest of walleye by commercial fishing in Long Point Bay summer by low quota

b) establishing license conditions that prevent walleye fishing with ca nets from June to August inclusive

c) overlap does not need to be addressed

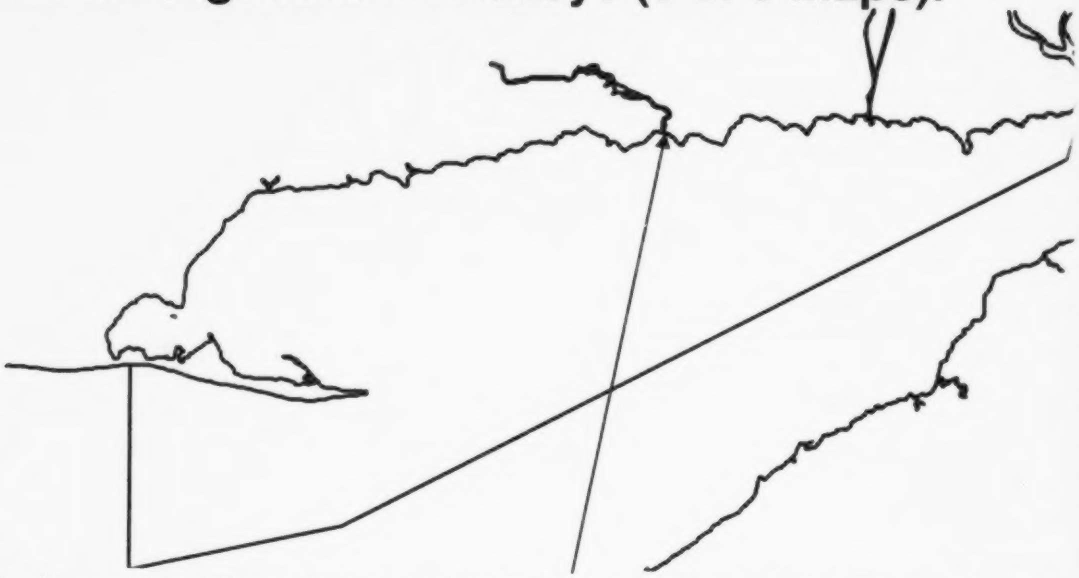
d) other…

Question 2. Management of walleye (4 of 5 maps)



2-6. Overlap of fishing activity between sport and commercial fisheries i

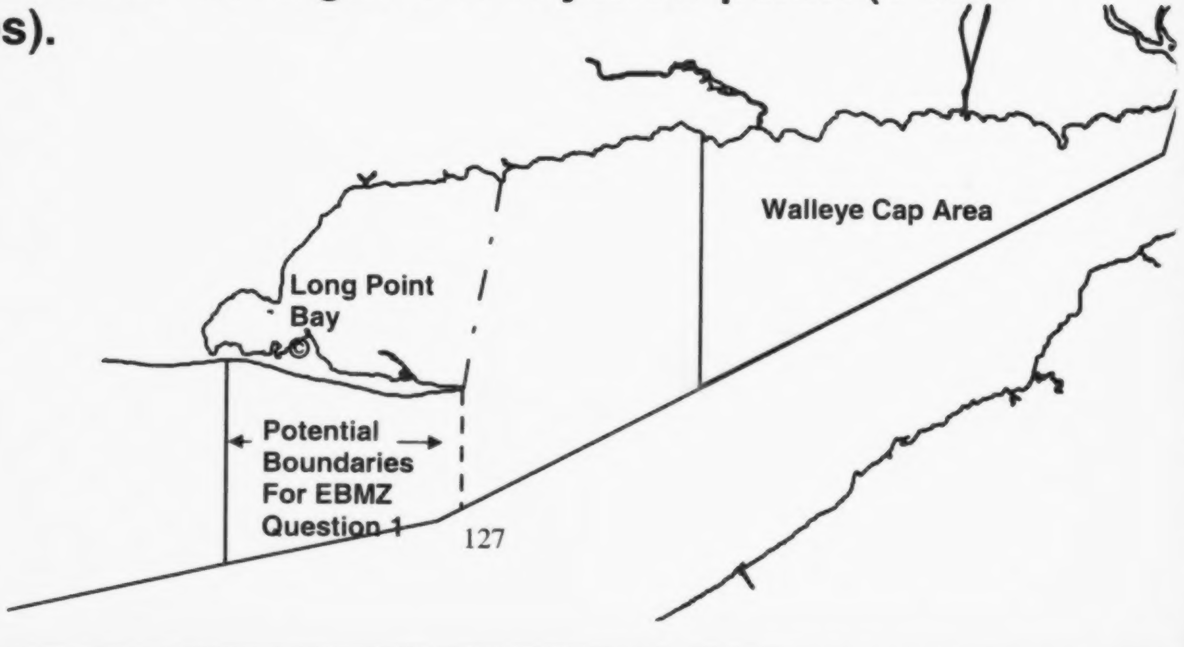
Question 2. Management of walleye (5 of 5 maps).



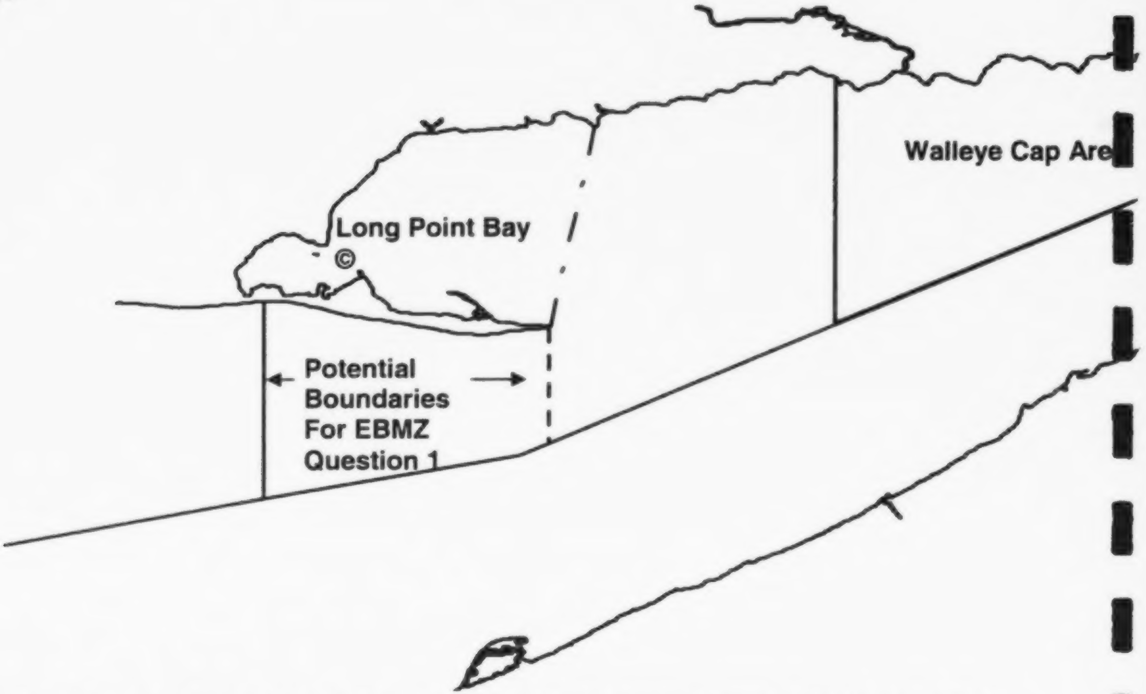
2-7. Harvest of small walleye from a stock that is being rehabilitated in the Grand River is viewed as a conservation issue by sport and commerci fishing interests. Harvest of small walleye downstream of Dunnville should be minimized by:

a) providing signs that provide the conservation message (in progress)
b) closed season in winter
c) restrictions on fishing near the dam
d) size limit on walleye
e) does not need regulation
f) other................

Question 3. Management of yellow perch (1 of 2 maps).

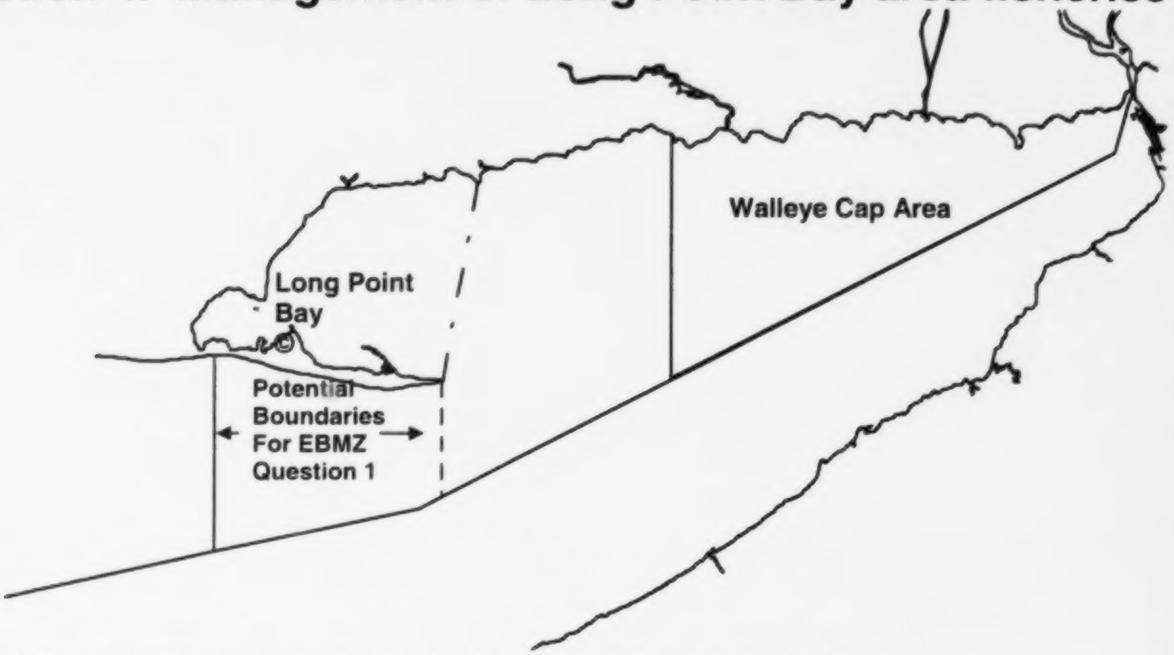

Walleye Cap Area
Long Point Bay
Potential Boundaries For EBMZ Question 1

Question 3. Management of yellow perch (2 of 2 maps).


Walleye Cap Are
Long Point Bay
©
Potential
Boundaries
For EBMZ
Question 1

3-2 OMNR should establish a harvest policy for yellow perch that will:
a) obtain close to maximum harvest in any given year, but incurs risk of ma
supply of fish from year to year,
b) optimize stability of fish supply, fishing success and fish size by optimiz
supply, fishing success and fish size by limits on exploitation rate and mes
c) use gear restrictions (mesh size) that promote a high quality yellow perc
Point Bay
d) other.....................

Question 4. Management of Long Point Bay area fisheries


Walleye Cap Area
Long Point Bay
Potential Boundaries For EBMZ Question 1

4-1. OMNR should manage Long Point Bay fisheries to optimize
a) the commercial fishery
b) the sport fishery
c) both fisheries

OMNR staff believe that a mix of commercial and sport fisheries is needed in order to obtain an optimal mix of benefits from the resource for the people of Ontario.

Appendix 2-B. Management alternatives questionnaire summary for Port Dover, Commercial Outreach Meeting, February 23, 2005. A total of 15 completed questionnaires were evaluated.

1-1 Boundary of management area

0%	a) boundary used during rehabilitation plan period (2000-2004)
100%	b) tip of Long Point
0%	c) other

2-1 Walleye: boundary of cap area

13%	a) current location (2000-2004)
87%	b) other

2-2 Walleye: regulate harvest

100%	a) no regulation
0%	b) regulate harvest in western part of zone
0%	c) regulate harvest or restrict fishery only within LPB
0%	d) regulate fishery following b) & c)

2-3 Walleye: harvest in cap area

0%	a) 32,000 lbs (2000-2004)
100%	b) set an alternative harvest level

2-4 Walleye: harvest increase in cap area

0%	a) no
100%	b) yes

2-5 Walleye: reduce fisheries overlap LPB

0%	a) limiting harvest of walleye by commercial fishing in LPB during summer by low quota
0%	b) establishing licence conditions that prevent walleye fishing with canned nets from June to August inclusive
47%	c) overlap does not need to be addressed
53%	d) other

2-6 Walleye: reduce fisheries overlap walleye cap area

0%	a) maintaining gentlemen's agreement concerning canned net fishing on weekends and during tournaments
0%	b) establishing licence conditions to do this
4%	c) establishing an area of net free waters in extreme eastern part of the walleye cap area
68%	d) overlap does not need to be addressed
29%	e) other

2-7 Walleye: conservation measures to protect small walleye downstream of Dunnville

0%	a) providing signs that provide the conservation message (in progress)
0%	b) closed season in winter
0%	c) restrictions on fishing near the dam
4%	d) size limit on walleye
0%	e) does not need regulation
96%	f) other

3-1 Yellow perch: boundaries within EBMZ

100%	a) as one unit, with no internal division

0%	b) as 2 areas, using the walleye cap area to separate areas for different management policy
0%	c) as 2 areas with an alternative boundary
0%	d) as one area except for a cap area (limiting commercial harvest and/or other fishery restrictions) in LPB
0%	e) other

3-2 Yellow perch: harvest policy

27%	a) obtain close to maximum harvest in any given year, but incurs risk of maximizing variation in supply of fish from year to year
73%	b) optimize stability of fish supply, fishing success and fish size by limits on exploitation rate and mesh size
0%	c) use gear restrictions (mesh size) that promote a high quality yellow perch fishery in LPB
0%	d) other

4-1 Long Point Bay Management

0%	a) the commercial fishery
0%	b) sport fishery
100%	c) both fisheries

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